

Research Report 1303

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PERSONNEL AND TRAINING SUBSYSTEM INTEGRATION IN AN ARMOR SYSTEM

John J. Kane
Science Applications, Inc.

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Research Report 1303

PERSONNEL AND TRAINING SUBSYSTEM INTEGRATION IN AN ARMOR SYSTEM

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**Office, Deputy Chief of Staff for Personnel
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January 1981

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Human Performance Effectiveness and Simulation

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FOREWORD

In recent years there has been an increasing awareness in the Army research and development community that personnel and training subsystems need to be better integrated into the material acquisition process. This research report, "Personnel and Training Subsystem Integration in an Armor System," is a preliminary step in meeting that need.

Researched by John Kane, Science Applications, Inc., this report was completed under Contract MDA903-80-C-0185 and the COR was Robert Bauer from the ARI Field Unit at Fort Knox, Kentucky.


JOSEPH ZEADNER
Technical Director

PERSONNEL AND TRAINING SUBSYSTEM INTEGRATION IN AN ARMOR SYSTEM

BRIEF

Requirement:

The purpose of this study was to conduct an audit trace of the personnel and training subsystem development of the XM1 Abrams Tank System as a case study of the major systems acquisition process. From this case study lessons learned from the XM1 experience have been formulated which may be helpful in developing recommendations for improving personnel and training subsystem integration in the Army Life Cycle System Management Model (LCSMM).

The scope of the study was restricted to personnel and training issues which occurred between program initiation and ASARC III. Other events in the XM1 development process were included only if they had a major impact on personnel and training issues or were required to make the development process comprehensible.

An implicit assumption of the study was that the LCSMM has two primary purposes. First, it is to provide a flexible, systematic procedure for developing effective, supportable materiel systems in a timely, cost-effective manner. Second, it should facilitate the provision of accurate, timely data on system status to permit intelligent, informed decision making by top management, to include the Department of the Army (DA), the Department of Defense (DoD), the Executive Office of the President, and the Congress.

PROCEDURE:

An advocacy method was developed and used in the execution of this study. This approach consisted of dividing the organizations involved in the XM1 acquisition cycle into six groups, each group representing some organizational perspective. Each group was assigned a study staff member (its "advocate") to research the activity of the organization he represented. A Senior Scientist Board (SSB) was appointed to represent the total systems viewpoint.

FINDINGS:

From its inception the XM1 program was driven by cost and schedule considerations, subject to intense pressure from the highest echelons of DoD and the Congress. Tank hardware had the highest visibility and was, hence, the pacing element in the development cycle. Personnel, training,

and logistics activities were of much lower visibility, especially in the early years of the program; hardware development continued whether or not they kept pace. In order to keep the project on schedule some critical LCSMM events were delayed or "passed through" (i.e., formalities required by DoD directives were completed, but the full substance of the event was lacking).

UTILIZATION OF FINDINGS:

Based upon the case study, the research team developed a number of conclusions concerning the LCSMM:

- The theory underlying the LCSMM is often at variance with DoD/DA management practices. The two need to be brought into closer alignment.
- Integrated Logistic Support issues need to be addressed early in the acquisition cycle to ensure supportability by initial fielding.
- Increased contractor responsibility for system design implies that Requests for Proposals be given wider and more careful review.
- An empirical data base should be developed to support quantification of training requirements.
- The impact of training should be incorporated into combat models and simulations.
- Personnel and training issues require higher visibility at top management levels.

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SECTION I INTRODUCTION

1.1 REQUIREMENTS

In recent years there has been an increasing awareness in the Army research and development community that personnel and training subsystems need to be better integrated into the materiel acquisition process. The research documented in this report is a preliminary step in meeting that need.

The specific purpose of this study was to conduct an audit trace of the personnel and training subsystem development of the XM1 Abrams Tank System as a case study of the major systems acquisition process. From this case study lessons learned from the XM1 experience have been formulated which may be helpful in developing recommendations for improving personnel and training subsystem integration in the Army Life Cycle System Management Model (LCSMM).

The scope of the study was restricted to personnel and training issues which occurred between program initiation and ASARC III. Other events in the XM1 development process were included only if they had a major impact on personnel and training issues or were required to make the development process comprehensible.

An implicit assumption of the study was that the LCSMM has two primary purposes. First, it is to provide a flexible, systematic procedure for developing effective, supportable materiel systems in a timely, cost-effective manner. Second, it should facilitate the provision of accurate, timely data on system status to permit intelligent, informed decision making by top management, to include the Department of the Army (DA), the Department of Defense (DoD), the Executive Office of the President, and the Congress.

1.2 ORGANIZATION OF THE REPORT

This report is organized into eight sections and three appendices. The order of presentation is: requirement for research (Section I), the research method (Section II), data collected (Sections III and IV), analysis of data (Sections V, VI, and VII), and analysis of the research method (Section VIII).

"Section II: Research Method" explains the "advocacy" approach applied to this study. The method employed influenced not only the collection and analyses of data, but also the organization and presentation of the report.

The initial data collection effort reviewed the current regulations and procedures governing the LCSMM. The results of this review are summarized in "Section III: Army Major System Acquisition." It should be emphasized that this section reviews current practices, which differ somewhat from those in force in the earlier stages of the XM1 program.

The primary effort of the study was devoted to a review of XM1 acquisition documents and interviews with past and present key project personnel. "Section IV: Audit Trace" is a detailed description of the facts uncovered in this process. This section is intended to be as factual and objective as possible with a minimum of analysis.

At the completion of the data collection effort the team members briefed a specially convened Senior Scientist Board (SSB). "Section V: Senior Scientists Board Briefing" summarizes the perspectives and guidance presented at that meeting.

Based on the guidance received from the SSB, the study team completed the data analysis. The results are presented in "Section VI: Study Issues" and "Section VII: Lessons Learned and Recommendations on the System Acquisition Process."

Since the research method employed is somewhat experimental in nature, a critique of its application in the study is presented in "Section VIII: Lessons Learned and Recommendations on the Research Method."

Appendix A contains a technical description of the XM1 Abrams Tank system for reference purposes. Appendix B is the study bibliography. Appendix C contains a list of acronyms used in the report.

SECTION II RESEARCH METHOD

2.1 OBJECTIVE

The overall problem under consideration is: How can the Army achieve a better integration of personnel and training subsystems development in the total system acquisition process? This research is a preliminary step in addressing that problem. The specific problem of this study is much more narrow and modest in scope: What lessons can be learned from the XM1 Tank System development process concerning the integration of personnel and training subsystems?

The objective of this research is to address the specific problem by conducting an audit trace and analysis of the personnel and training subsystems development for the XM1 Tank System through ASARC III. Achieving this objective will contribute to the long term objective of developing methods for the assessment and control of the timely integration of these subsystems into the acquisition cycle.

2.2 TECHNICAL APPROACH

Science Applications, Incorporated (SAI) chose an "advocacy" approach for this study. This approach consisted of dividing the organizations involved in the XM1 acquisition cycle into six groups, each group representing some organizational perspective. Each group was assigned a study staff member (its "advocate") to research the activity of the organization he represented.

The six groups are as follows:

<u>ADVOCATE</u>	<u>AGENCIES</u>
1. Proponent	TRADOC
2. Materiel Developer	DARCOM (except PM TRADE)
3. Operational Tester	OTEA
4. Logistician	LEA
5. Training Devices Developer	PM TRADE
6. Executive Management	HQDA

A Senior Scientist Board (SSB) represented the total systems viewpoint. After data collection was completed, the advocates briefed the SSB on the history of the XMI, each advocate presented the actions of the organization he represented from the viewpoint of that organization. The purpose of the SSB briefing was to capture both the dynamics of the acquisition cycle as well as the role of conflicting organizational perspectives. The SSB provided formal guidance to the study team on the lessons learned and issues analyses to be conducted.

The study was divided into three tasks:

Task 1: Organization and Data Collection

Task 2: Audit Trace

Task 3: Final Analysis and Report.

Task 1 covered the development of the study data structures and the review of the regulations, directives, and pamphlets governing the acquisition cycle. Task 2 included the review of XMI documentation and discussions with XMI key personnel and concluded with the SSB briefing and SSB guidance. Task 3 covered the lessons learned analysis and the draft and final reports.

2.3 PRESENTATION OF RESULTS AND ANALYSIS

The central point of the research effort and the key to understanding the study results is the SSB briefing. However, the briefing itself was an "event"--a long one, lasting over six hours--and somewhat difficult to capture in a report. This final report has been structured so that as much as possible of the flavor of the technical approach comes through without being overly repetitious or disorganized.

The audit trace, which is contained in Section IV, is intended to be an objective compendium of the facts gathered by the advocates. It is not intended to reflect the viewpoints of any of the advocates. Where subjective opinions are expressed, they represent opinions expressed by an individual interviewed or a document reviewed--and are footnoted as such.

Section V is directly concerned with the SSB briefing. The section opens with short statements by each of the advocates on his perception (in a role playing mode) of what the major problems of the XM1 were and how they relate to the LCSMM. This is followed by an analysis of proposed and actual XM1 schedules and a discussion of some of the system interface problems. The section concludes with a summary of the guidance given the study team by the board, which is reflected in the succeeding analysis.

SECTION III ARMY MAJOR SYSTEM ACQUISITION

This section presents an overview of the research, development, and acquisition process by which the Army brings new major systems into the inventory. System acquisition is governed by a large and complex series of guidelines and directives issued by various interested organizations, from the Executive Office of the President down to major Army commands. These guidelines are intended to be both comprehensive and flexible; consequently they contain a wide variety of options and alternatives.

The overview presented here is a "snapshot" of the acquisition cycle as it is presently defined. Conflicts between regulations have generally been resolved on a most-recent-date basis. Only a discussion of major systems is considered herein.

3.1 OFFICE OF MANAGEMENT AND BUDGET GUIDANCE

The Executive Office of the President exercises primary control over the acquisition cycle through the Office of Management and Budget (OMB). Policy guidelines have been promulgated by the Office of Federal Procurement Policy (OFPP) in OMB Circular A-109.¹

A-109 policy applies to all major federal acquisitions from hospitals and energy demonstrations to defense and space programs. Figure 3-1² shows the A-109 acquisition cycle. Four key decision points³ are shown in the figure.

¹ Major Systems Acquisition, OMB Circular A-109. OMB, Washington, D.C.: April 5, 1976. (See also: Major Systems Acquisition: A Discussion of the Application of OMB Circular No. A-109, OFPP Pamphlet No. 1. OFPP, Washington, D.C.: August 1976)

² Source: OPFF Pamphlet No. 1, op. cit., p. 21.

³ A-109 decision points 1, 2, 3 and 4 correspond to the Army's Milestone 0, Milestone I (ASARC/DSARC I), Milestone II (ASARC/DSARC II), and Milestone III (ASARC/DSARC III), respectively.

MAJOR SYSTEM ACQUISITION CYCLE

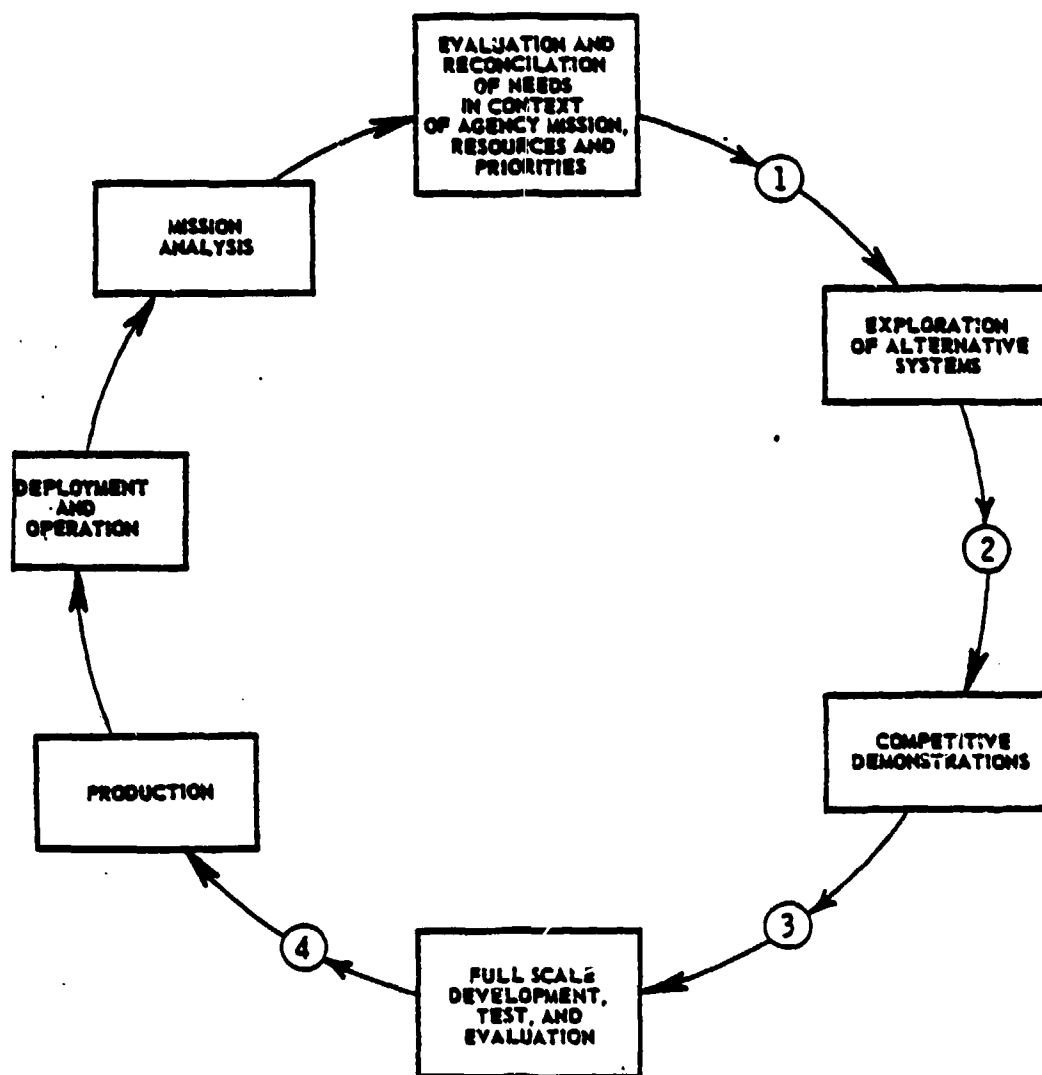


FIGURE 3-1. A-109 ACQUISITION CYCLE

At the first key decision point the proponent agency must establish its requirement for the new acquisition in terms of its mission. This is accomplished through the Mission Need Statements.

This is followed by an exploration of alternative systems to meet the mission need. The second key decision point selects one or more of these alternatives.

The philosophy of A-109 calls for two or more parallel, short-term contracts followed by competitive tests. The third decision point selects a single contractor to proceed with Full Scale Engineering Development (FSED).

After extensive test and evaluation under operational conditions, a production decision is made. This is the fourth key decision point.

The A-109 process is primarily concerned with validating the need for and controlling the expenditure of funds; hence, personnel and training considerations are not explicitly defined therein. However, personnel and training considerations are (or should be) implicit in the analysis of alternative systems, the selection from competitive demonstrations, and the pre-production test and evaluations.

Implementation of the A-109 philosophy has been slow and difficult throughout the government. The Department of Defense (DoD), which has taken the lead, has encountered many problems and new DoD directives are currently being developed to clarify the situation.

3.2 DEPARTMENT OF DEFENSE REGULATIONS

DoD policy and OMB Circular A-109 are implemented through a long list of DoD Directives (DoDDs) and Instructions (DoDIs). The key directives for the acquisition cycle are currently DoDD 5000.1,⁵ DoDD 5000.2,⁶ and DoDD 5000.30.⁷ However, these three directives are

⁴ This corresponds to the Army's Mission Element Need Statement (MENS), which should not be confused with the Materiel Need (MN).

⁵ DoDD 5000.1, Major System Acquisition. January 18, 1977.

⁶ DoDD 5000.2, Major System Acquisition Process. January 18, 1977.

⁷ DoDD 5000.30, Defense Acquisition Executive. August 20, 1976.

expected to be soon superseded by a new DoDD 5000.1⁸ and DoDI 5000.2,⁹ so the discussion herein will address the new documents.

The Office of the Secretary of Defense (OSD) is primarily concerned with four major decision points: approval of the Mission Element Need Statement (MENS) and the Defense System Acquisition Review Councils (DSARCs) I, II, and III. Consequently, DoDD 5000.1 and DoDI 5000.2 are primarily directed at preparing for, executing, and following up actions taken at these decision points.

The key document at Milestone 0 is the MENS. This document is limited to five pages and must consider the mission, threat, need, constraints, and schedule. Manpower considerations are the only part of the constraints related to personnel and training issues.

The key documents for entry into the three DSARCs are the Decision Coordinating Papers (DCPs) and the Integrated Program Summaries (IPSS). The DCP is concerned primarily with funding and schedule. The IPS, however, specifically directs the services to consider manpower and training alternatives as well as provide an overview of the test and evaluation plan.

The IPS is a new requirement and it remains to be seen what, if any, impact it has on human dimension aspects of systems development. It does require consideration of the impact of alternatives on manpower and training, including job-task identification, requirements for training aids and devices, and plans for testing and evaluating manpower and training requirements. The manpower and training sections of the IPS are each limited to two pages.

Recent concern over the long term manpower outlook has caused the Assistant Secretary of Defense (Manpower, Reserve Affairs & Logistics) (ASD(MRA&L)) to require a formal Manpower Analysis Paper (MAP) to support each major milestone.^{10, 11} The MAP presents an

⁸ DoDD 5000.1, Major System Acquisition (Formal Coordination Draft). October 17, 1979.

⁹ DoDI 5000.2, Major System Acquisition Procedures (Formal Coordination Draft). October 17, 1979.

¹⁰ ASD(MRA&L) Memorandum, Subject: Manpower Analysis Requirements for System Acquisition. August 17, 1978.

¹¹ For an example, see: Manpower Analysis Paper (MAP) III AN/TTC-39 Circuit Switch and AN/TYC-39 Message Switch. U.S. Army Signal Center and Fort Gordon: December 4, 1979.

analysis of the manpower requirements by Military Occupational Specialty (MOS) and skill level for each unit type. It specifies trade-offs among manpower, design, and logistics elements.

3.3 DEPARTMENT OF THE ARMY REGULATIONS

The Department of the Army (DA) implements DoD guidance through Army Regulation (AR) 1000-1¹² and supporting ARs and DA pamphlets and circulars. Additional guidance is provided by supplementary regulations, pamphlets, and circulars issued by subordinate commands.

This paragraph presents a three part overview of the implementation of AR 1000-1. The first part discusses the roles of the key participating commands. The second considers the role of test and evaluation (T&E). The last traces the Army Life Cycle System Management Model (LCSMM).

3.3.1 Major Responsibilities

The Army has divided the responsibilities of the system acquisition cycle into four major areas: The proponent (or user's representative), the materiel developer, the operational tester, and the logistician. Guidance, coordination, and OSD interface is provided by the DA staff.

3.3.1.1 Proponent

The system proponent, or user's representative, is the US Army Training and Doctrine Command (TRADOC). TRADOC's responsibilities are divided between Combat Developments and Training Developments. Each system is assigned to a school or center.¹³

For each major system, a TRADOC System Manager (TSM) is chartered by the Commanding General, TRADOC, to be the focal point for all TRADOC activities and the point of contact for other commands. He tasks TRADOC organizations and ensures compliance with TRADOC requirements.

¹² AR 1000-1, Basic Policies for Systems Acquisition. April 1, 1978.

¹³ XM1 is assigned to the US Army Armor Center.

As combat developer, TRADOC establishes the need and sets the requirements for new systems. It also establishes manpower and personnel requirements.

As training developer, TRADOC designs and executes training programs. It must also review and approve training materiel procured by the materiel developer. TRADOC establishes requirements for training devices and is responsible for certifying that players on operational tests are adequately trained.

3.3.1.2 Materiel Developer

The Materiel Development and Readiness Command (DARCOM) is the Army's materiel developer. For each major system a Project Manager (PM), chartered by the Secretary of the Army and assigned to a commodity command,¹⁴ acts as DARCOM's principal agent. The PM is responsible for developing a total program acquisition strategy. His primary concern is the development of hardware, on time and within funding constraints. Other major responsibilities include the following:

- Logistic support planning
- Preparation of baseline cost estimates in accordance with work breakdown structure
- Preparation of outline development plan, development plan, resident training plan, and new equipment training plan
- Development of independent parametric cost estimates
- Producibility engineering and planning
- Identification of long lead time component requirements
- Initial Qualitative and Quantitative Personnel Requirements Information (QQPRI) and MOS decisions

¹⁴ XM1 is assigned to the Tank-Automotive Command (TACOM).

- Contract award for low rate initial production and initial production facilities
- Development of technical manuals
- Coordination with test agencies.

As the focal point for scheduling and funding, the PM is, in practice, the single most powerful voice in the system acquisition cycle.

Because of the increasing complexity and cost of training devices, DARCOM established the PM for Training Devices (PM TRADE) for both system and non-system training devices. PM TRADE is chartered by the Secretary of the Army and reports directly to DARCOM. Originally, PM TRADE was available to any PM who requested assistance. More recently, DARCOM has required that every PM consult with PM TRADE.

PM TRADE is funded by the system PM and there is generally close coordination between the two PM offices. In other respects, PM TRADE's responsibilities for training devices exactly parallel that of the system PM for materiel. PM TRADE responds to the proponent's requirements (through the TSM). He is responsible for developing a training device acquisition strategy within the context of the system acquisition strategy.

3.3.1.3 Operational Tester

The Army's independent agent for operational test and evaluation is the US Army Operational Test and Evaluation Agency (OTEA), an agency of the Office of the Chief of Staff, Army, generally working directly with the Vice Chief of Staff, Army.

OTEA is responsible for planning, managing, and independently evaluating all operational tests (OTs) for all major systems. OTEA will generally assign the conduct of an OT to a TRADOC test agency with players from a field unit.

3.3.1.4 Logistician

The Logistician for the Army acquisition cycle is the US Army Logistics Evaluation Agency (LEA), an agency of the DA Deputy Chief of Staff for Logistics (DCSLOG). LEA's activities are, however, confined almost entirely to review. Logistics requirements are generally set by TRADOC and logistics planning is primarily the responsibility of the PM.

3.3.1.5 Department of the Army Staff

The Army staff provides overall program coordination and integration of the materiel system into Army. The focal point for DA activities for a system is the DA System Coordinator (DASC) in the Office of the Deputy Chief of Staff for Research, Development, and Acquisition (DCSRDA).

The Deputy Chief of Staff for Operations and Plans (DCSOPS) is responsible for establishing and validating capability goals, materiel objectives and requirements, overall force structure design, basis of issue plans, and user testing. DCSOPS establishes priorities for materiel requirements, development, affordability determinations, and procurement of equipment. DCSOPS designates programs as major programs and has primary responsibility for supervising Special Task Forces (STFs).

Staff responsibility for reviewing logistic support belongs to DCSLOG. DCSLOG is especially concerned with integrating system logistic support into the total Army system.

The Office of the Deputy Chief of Staff for Personnel (DCSPER) and its agency, the Military Personnel Center (MILPERCEN), have responsibility for developing a personnel system to meet the needs of new or improved doctrine, organization, and materiel including the determination of new or revised MOSs. MILPERCEN also develops the MILPERCEN Initial Recruiting and Training (MIRAT) Plan.

The Army Research Institute for the Behavioral and Social Sciences (ARI) is an agency of DCSPER and is responsible for supervising and conducting behavioral sciences research, including assessment of quantitative and qualitative manpower resources and requirements systems for individual and unit training, and human factors affecting military operations. While ARI is not specifically mandated to participate in any given activity in the acquisition cycle, it frequently provides assistance on a request basis.

3.3.1.6 User

The users are Army field organizations, e.g., the Forces Command (FORSCOM) or US Army, Europe (USAREUR). The user is not an official participant in the acquisition cycle, but is represented by TRADOC. In practice, however, coordination with user units for input and force development testing can be critical in systems development.

3.3.2 Test and Evaluation

3.3.2.1 Types of Test and Evaluation

Developmental test and evaluation (DT&E) is conducted to assist the engineering design and development processes and to verify attainment of technical performance specifications and objectives. As such, it is critical to determining whether or not a system is acceptable for military use. It is accomplished in factory, laboratory, and proving ground environments using experienced and qualified civilian and military personnel. To the maximum extent possible, contractor and government development testing is integrated into one test cycle during the demonstration and validation phase and another during the full-scale engineering development phase of the materiel acquisition process.

Operational test and evaluation (OT&E) is that test and evaluation conducted to estimate a system's operational effectiveness (including military utility, vulnerability, and survivability), and operational suitability (including compatibility, rationalization, standardization, interoperability, reliability, availability, maintainability, logistic supportability, safety, health, human factors, and trainability), as well as the need for any modifications. In addition, OT&E, provides information on organization, personnel requirements, doctrine, and tactics.

Operational test and evaluation is accomplished by units consisting of operational and support personnel for the type and qualifications of those expected to use and maintain the system when deployed, and is conducted in as realistic an operational environment as possible. A realistic operational environment includes tactical operations conducted in accordance with the combat developer's operational mode summary which specifies the number and type of combat operations during a period of time. The environment under which these operations are conducted may include the employment of opposing forces; electronic and other enemy counter-measures; chemical, biological, and radiological warfare; and smoke or other forms of battlefield obscuration. Where appropriate, operations may be conducted in urban training areas. Independent evaluations of operational tests are provided directly to each member of the decision review body.

Force development test and experimentation (FDTE) are tests that are performed to support the force development processes by

examining the impact, potential, effectiveness, and interdependence of selected concepts, tactics, doctrine, organization, and materiel. They support the materiel acquisition process by providing data to assist in the development of requirements, to develop fundamental data necessary for a full understanding of the performance of a materiel system, or to assist in validating doctrine and/or tactics to counter a possible threat response to a system once deployed. FDTE may be used to develop the concept of employment, determine operational feasibility, estimate the potential operational advantage of a proposed system, and assist the combat and materiel developers in the development of requirements documents.

3.3.2.2 An Example of the Test Cycle

The six basic test cycle documents and the process they follow are shown in Figure 3-2. These same documents are shown in Figure 3-3 with enough elaboration to reflect the OT&E process within a cycle.

The OT&E cycle starts with identification of operational issues (or a revision of them if there was a previous cycle) by proponent commands or agencies. The issues form the basis for initiating (or revising) the Independent Evaluation Plan (IEP). The IEP programs the use of all available data, regardless of source, to evaluate the system's operational effectiveness and suitability. When the IEP is sufficiently developed to identify what data are required from operational tests and operational performance criteria, test concepts are prepared (or revised) for each required OT. The test concept also forms the basis for preparing (or revising) an outline test plan (OTP) for each required operational test.

After the IEP for a phase is approved, the test design plan (TDP) is prepared. The TDP delineates only as much of the test planning as is necessary for the approval authority to be assured that the test will satisfy its objectives, leaving some flexibility in the detailed planning to the test director. Preparation of the TDP requires input from the materiel developer concerning maintenance and new equipment training (NET) and from the combat developer and trainer concerning means of employment, organization, logistical concepts, threat, mission profiles, test environment, and training. The inputs are referred to as the materiel developer test support package (TSP) and the combat developer TSP. When the TDP has been approved a detailed test plan (TP) is prepared and used by the test director.

After the test has been conducted, the test organization reports the conditions under which the test was run and the data results. The test reports are limited to findings of fact, including such summary calculations as are called for in the test design plan, but do not draw inferences, make recommendations, or advance evaluative judgements. The designated independent evaluator reports a conclusion for each operational issue of the test with due consideration to any relevant criteria which may exist, along with an evaluation of the adequacy and validity of the operational test. The conclusion as to operational effectiveness of the evaluated system or item contained in the Independent Evaluation Report (IER) is based on data from all sources including DT, OT, FDTE, studies, simulations, and analysis, and takes into account the validity and relevance of each datum source. The operational IER, then, is supplied as one of several documents directly to the ASARC for their consideration. The decision resulting from the ASARC is the basis for revising the operational issues and repeating the cycle, unless the decision is the final one in the acquisition cycle.

3.3.3 Life Cycle System Management Model

The LCSMM is an event-step process by which Army materiel systems are initiated, validated, developed, deployed,¹⁵ supported, modified, and disposed. Promulgated in DA Pamphlet 11-25,¹⁵ the LCSMM summarizes and organizes the requirements of AR 1000-1 and its supporting regulations and circulars.

Unfortunately, the LCSMM has not been revised since 1975, making it considerably out of date. This paragraph provides an overview of an updated LCSMM from program initiation until the production and deployment decision. The emphasis is placed on personnel and training related events. Figure 3-4 illustrates the LCSMM.

3.3.3.1 Program Initiation (Milestone 0)

As part of its mission, TRADOC conducts continuing analyses of mission areas to identify requirements for enhanced capabilities. When a mission need is identified, TRADOC, in coordination with

¹⁵ DA Pamphlet 11-25, Life Cycle System Management Model for Army Systems. HQDA: May 1975.

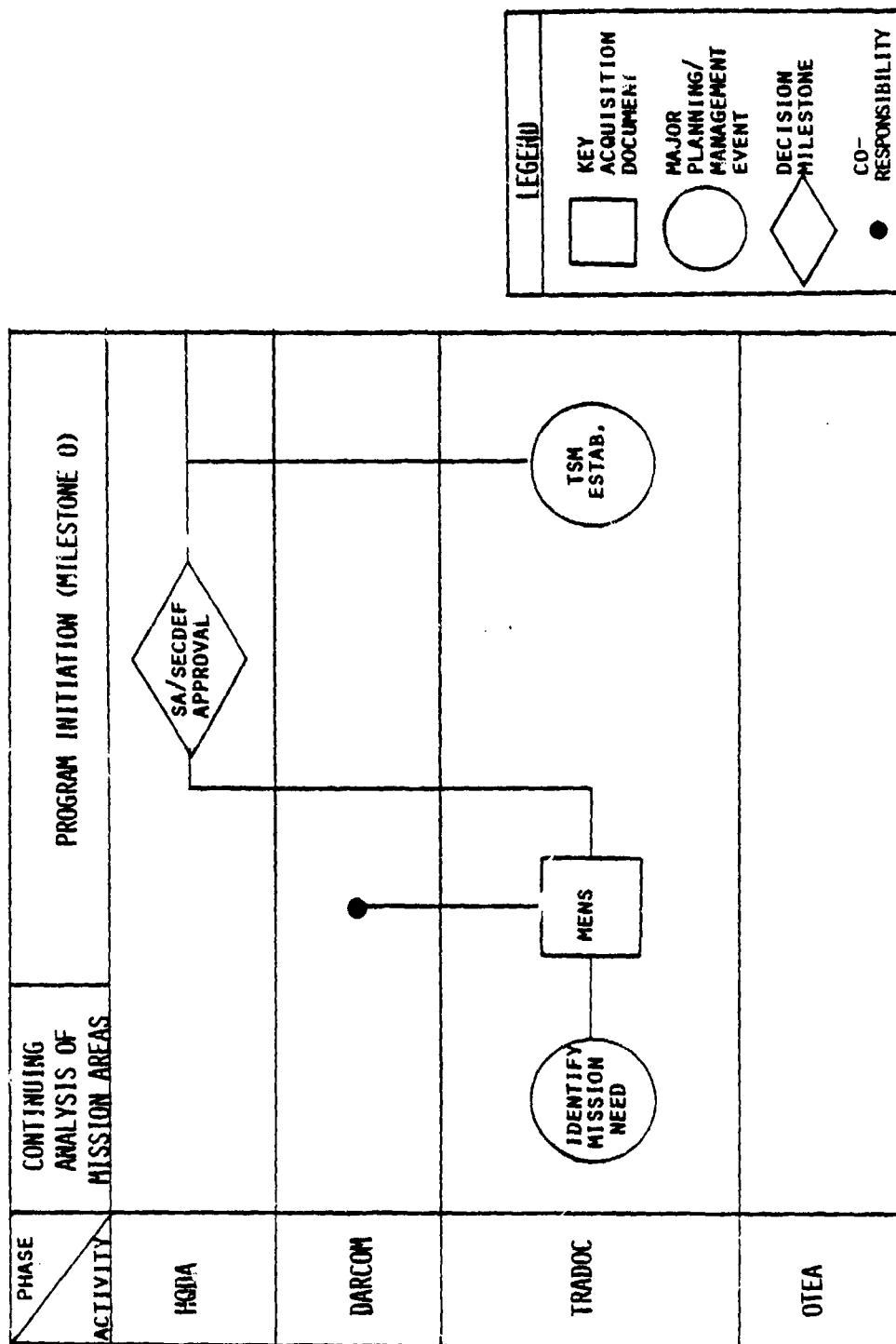


FIGURE 3-4. LIFE CYCLE SYSTEM MANAGEMENT MODEL (PART 1 OF 11)

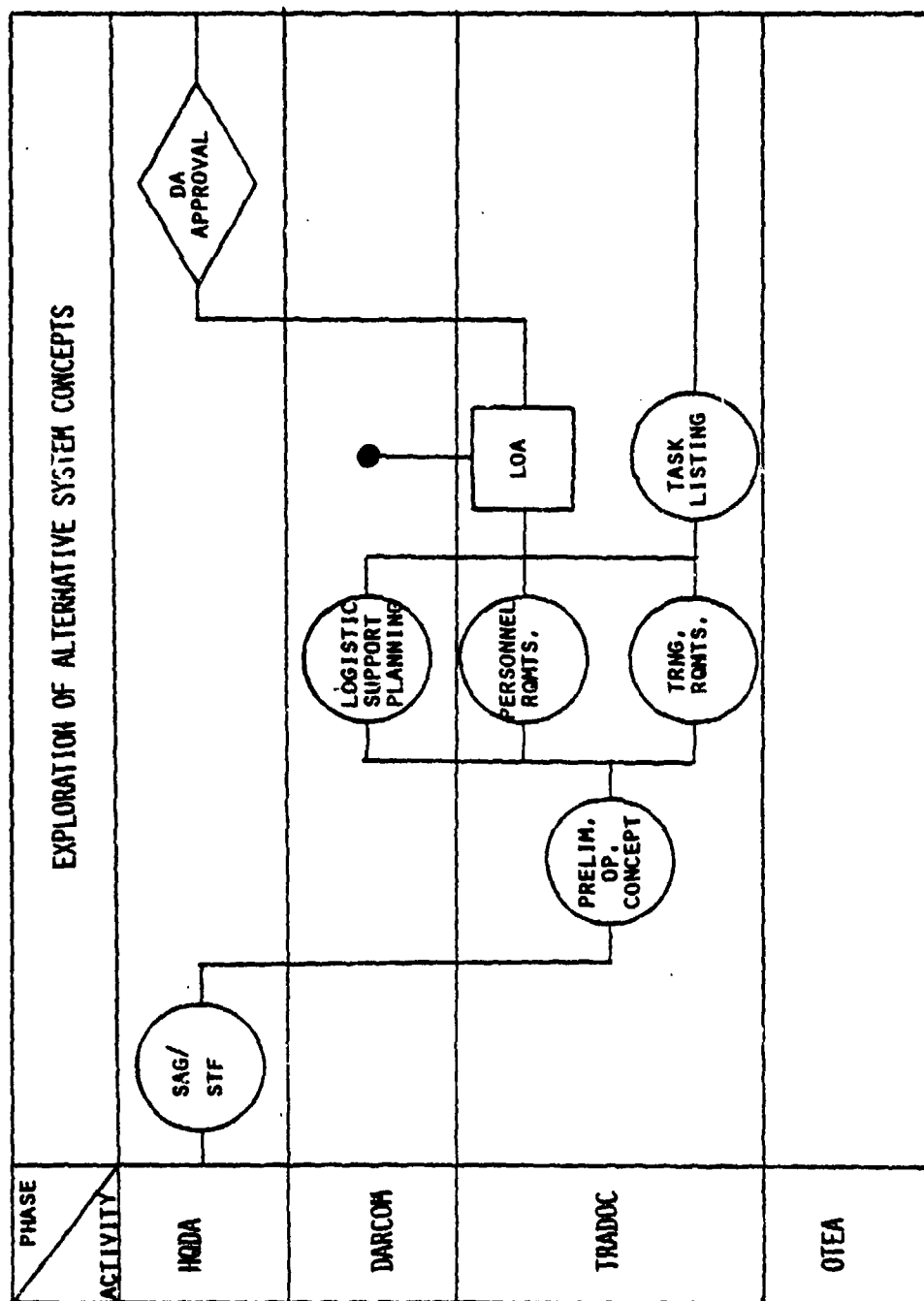


FIGURE 3-4. LIFE CYCLE SYSTEM MANAGEMENT MODEL (PART 2 OF 11)

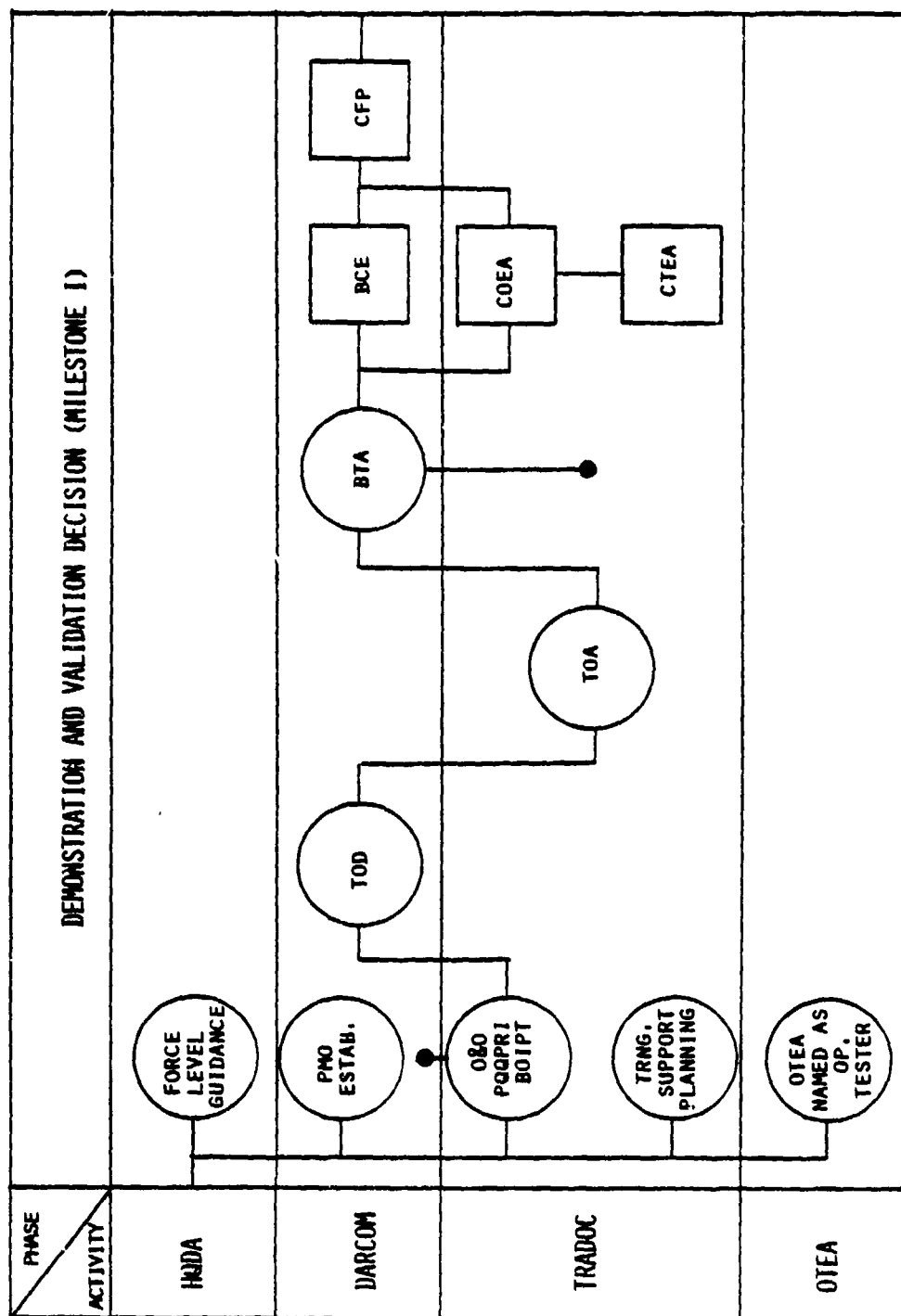


FIGURE 3-4. LIFE CYCLE SYSTEM MANAGEMENT MODEL (PART 3 OF 11)

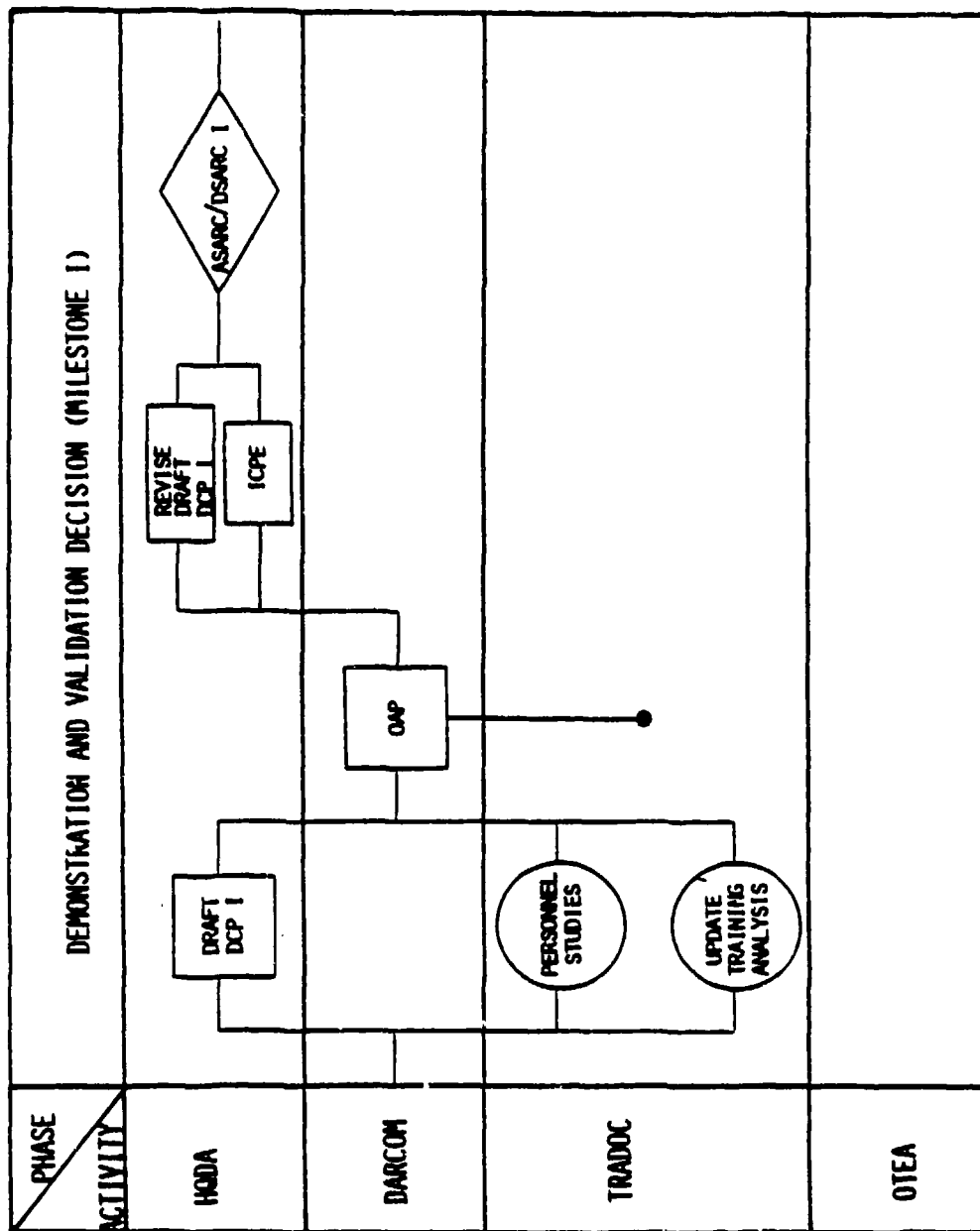


FIGURE 3-4. LIFE CYCLE SYSTEM MANAGEMENT MODEL (PART 4 OF 11)

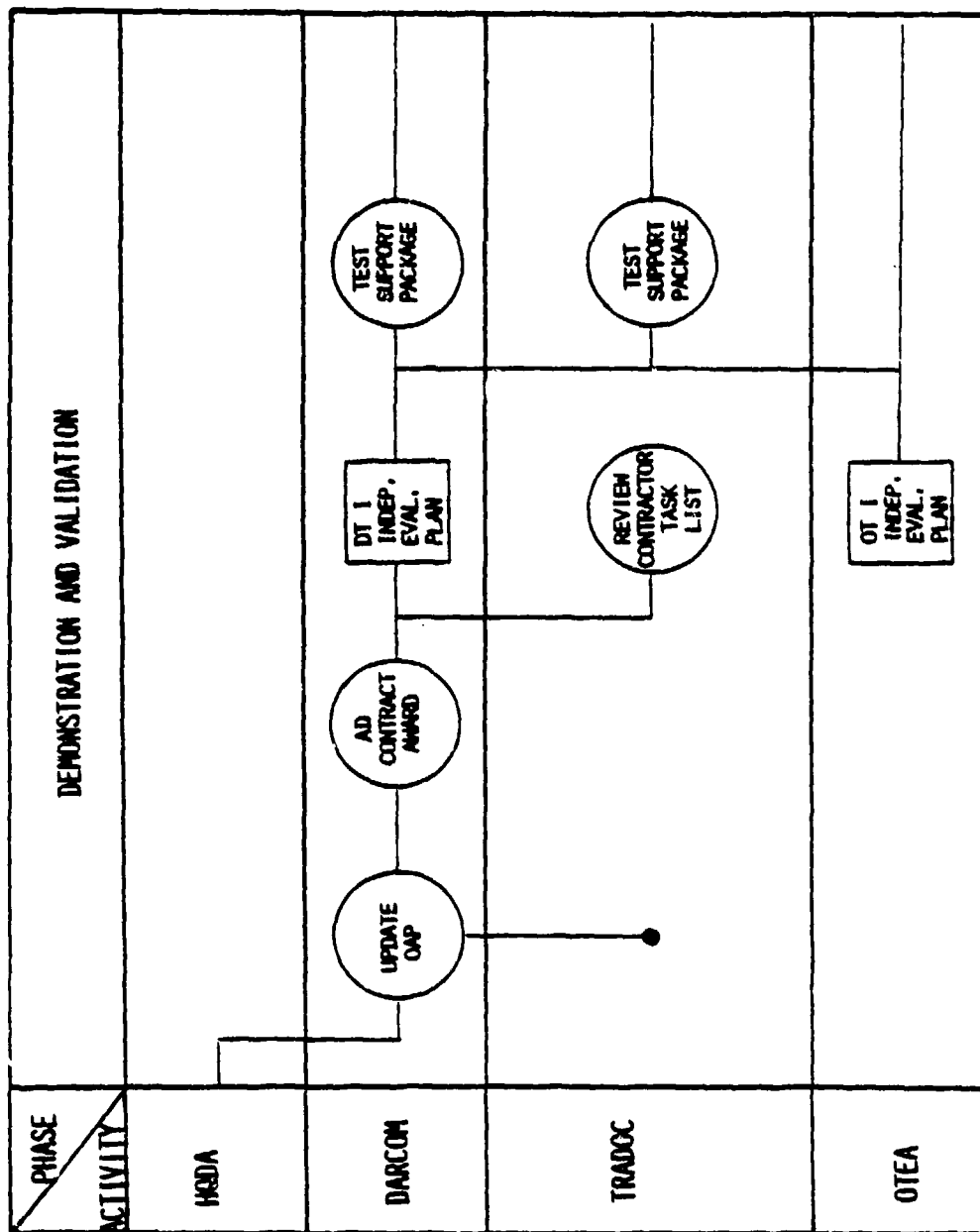


FIGURE 3-4. LIFE CYCLE SYSTEM MANAGEMENT MODEL (PART 5 OF 11)

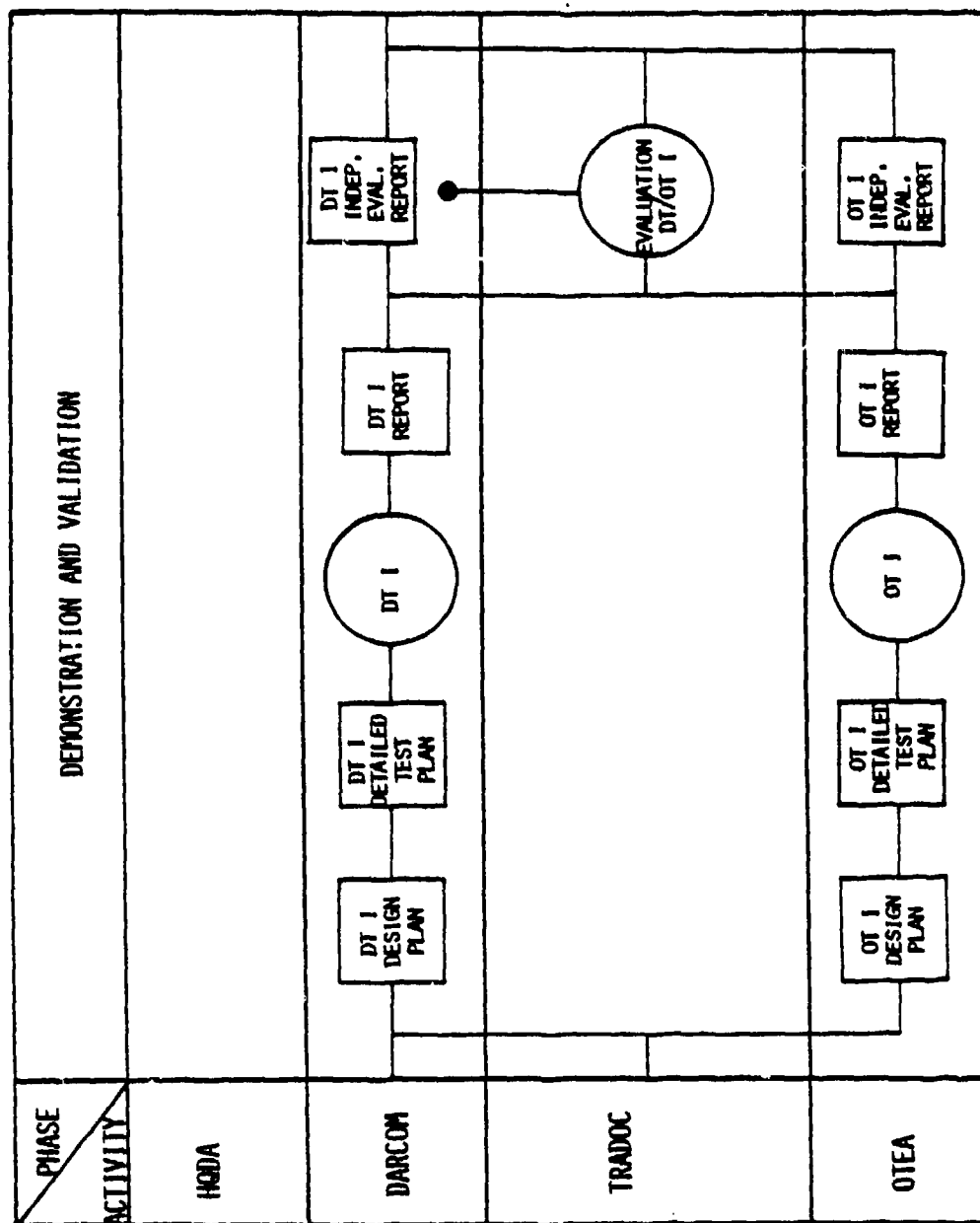


FIGURE 3-4. LIFE CYCLE SYSTEM MANAGEMENT MODEL (PART 6 OF 11)

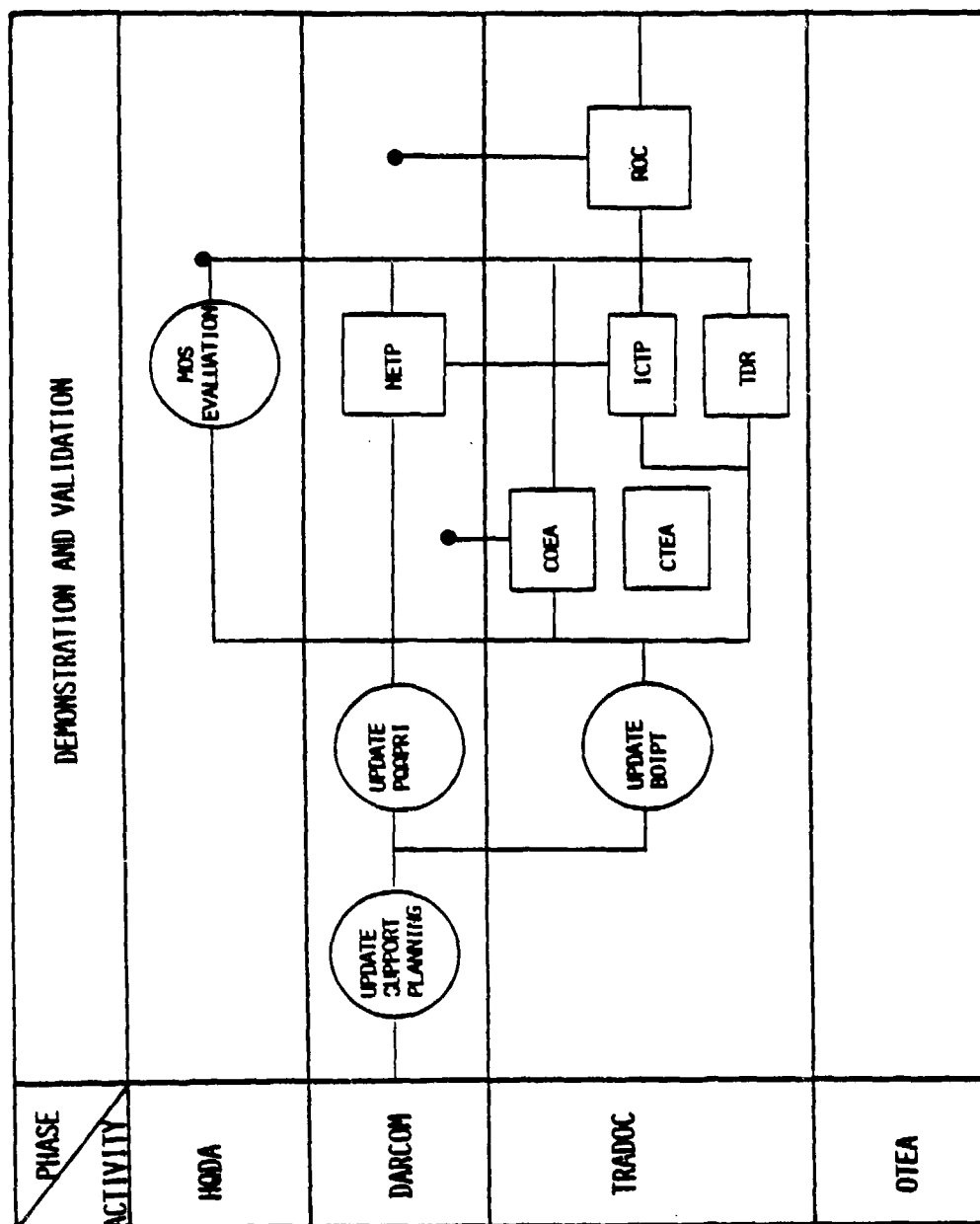


FIGURE 3-4. LIFE CYCLE SYSTEM MANAGEMENT MODEL (PART 7 OF 11)

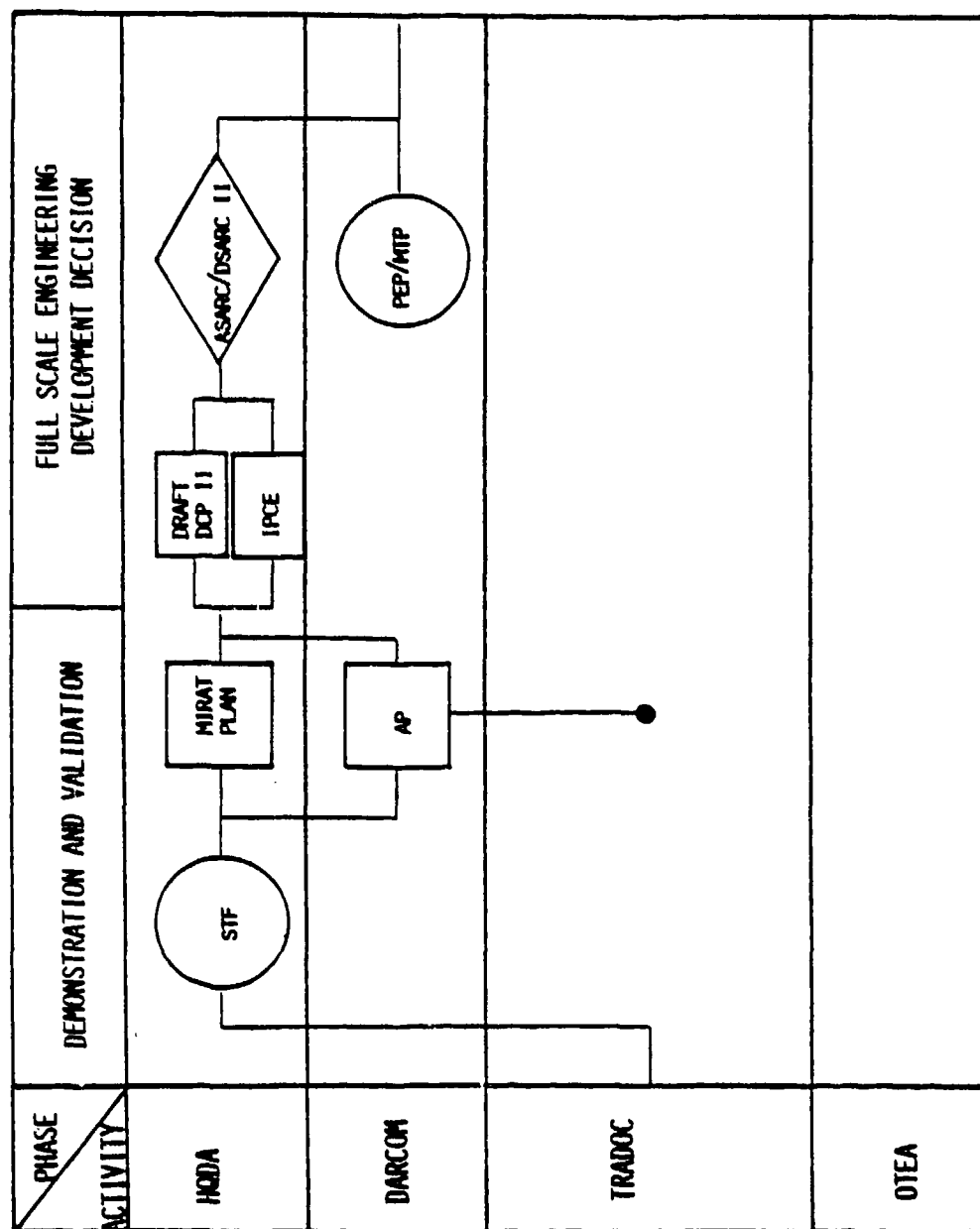


FIGURE 3-4. LIFE CYCLE SYSTEM MANAGEMENT MODEL (PART 8 OF 11)

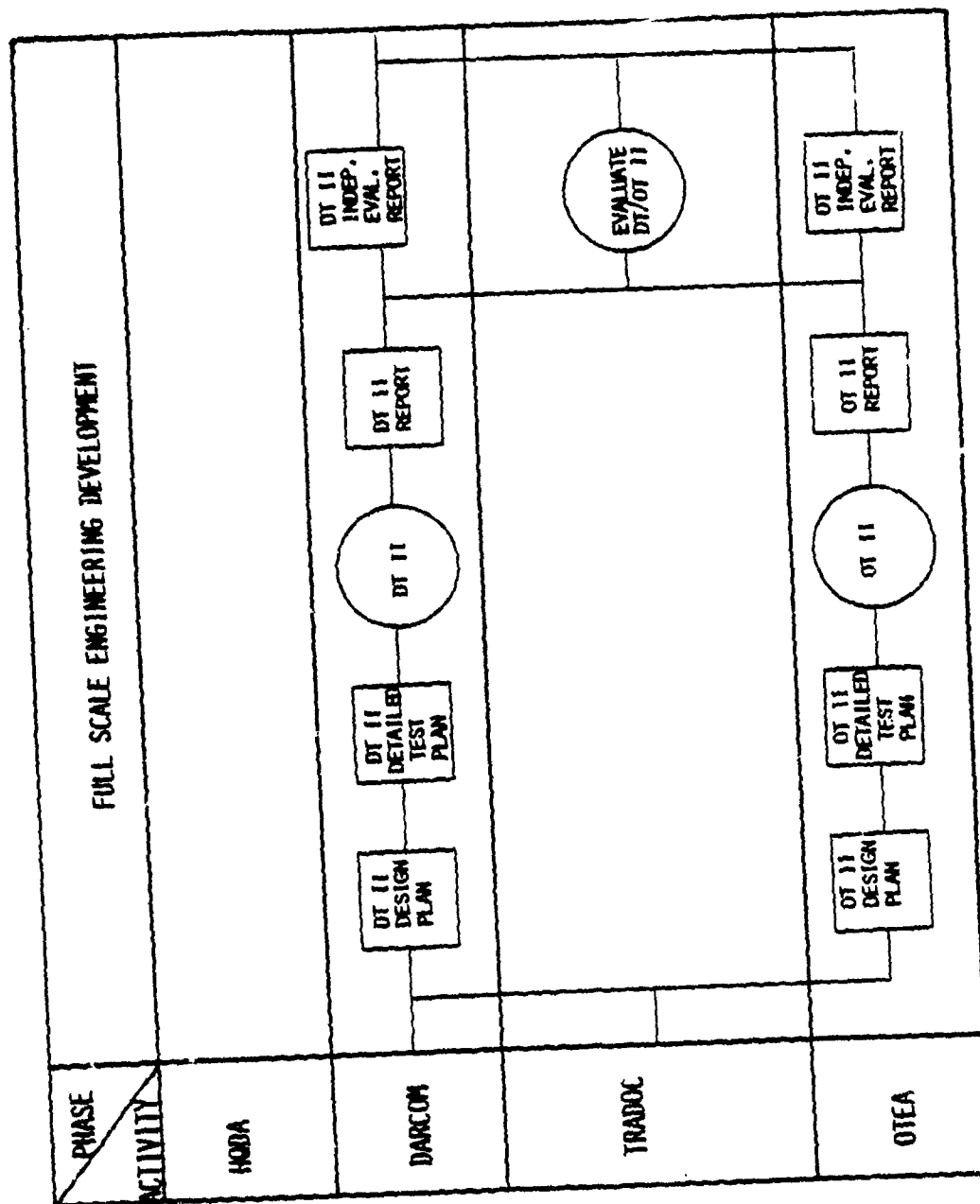


FIGURE 3-4. LIFE CYCLE SYSTEM MANAGEMENT MODEL (PART 9 OF 11)

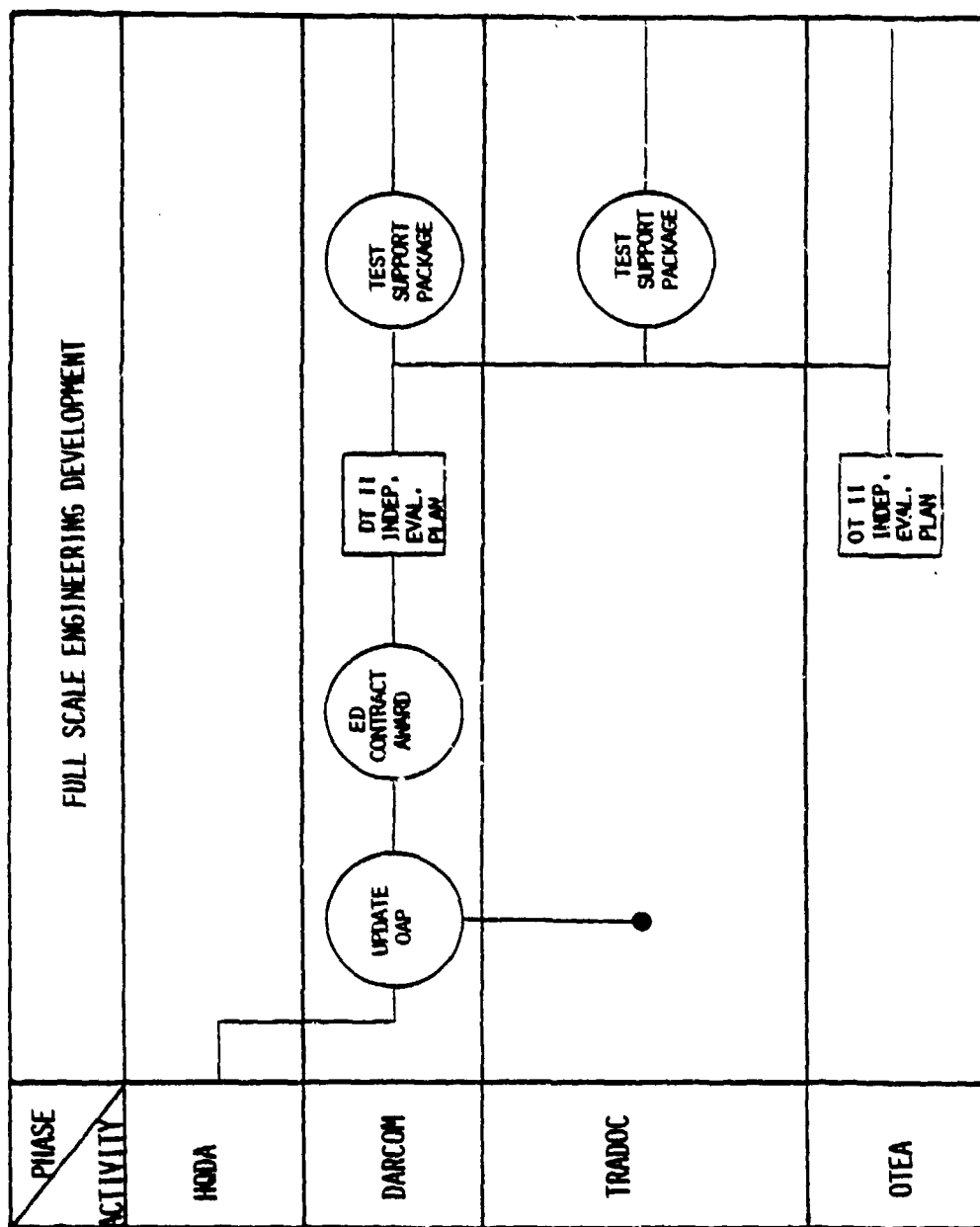


FIGURE 3-4. LIFE CYCLE SYSTEM MANAGEMENT MODEL (PART 10 OF 11)

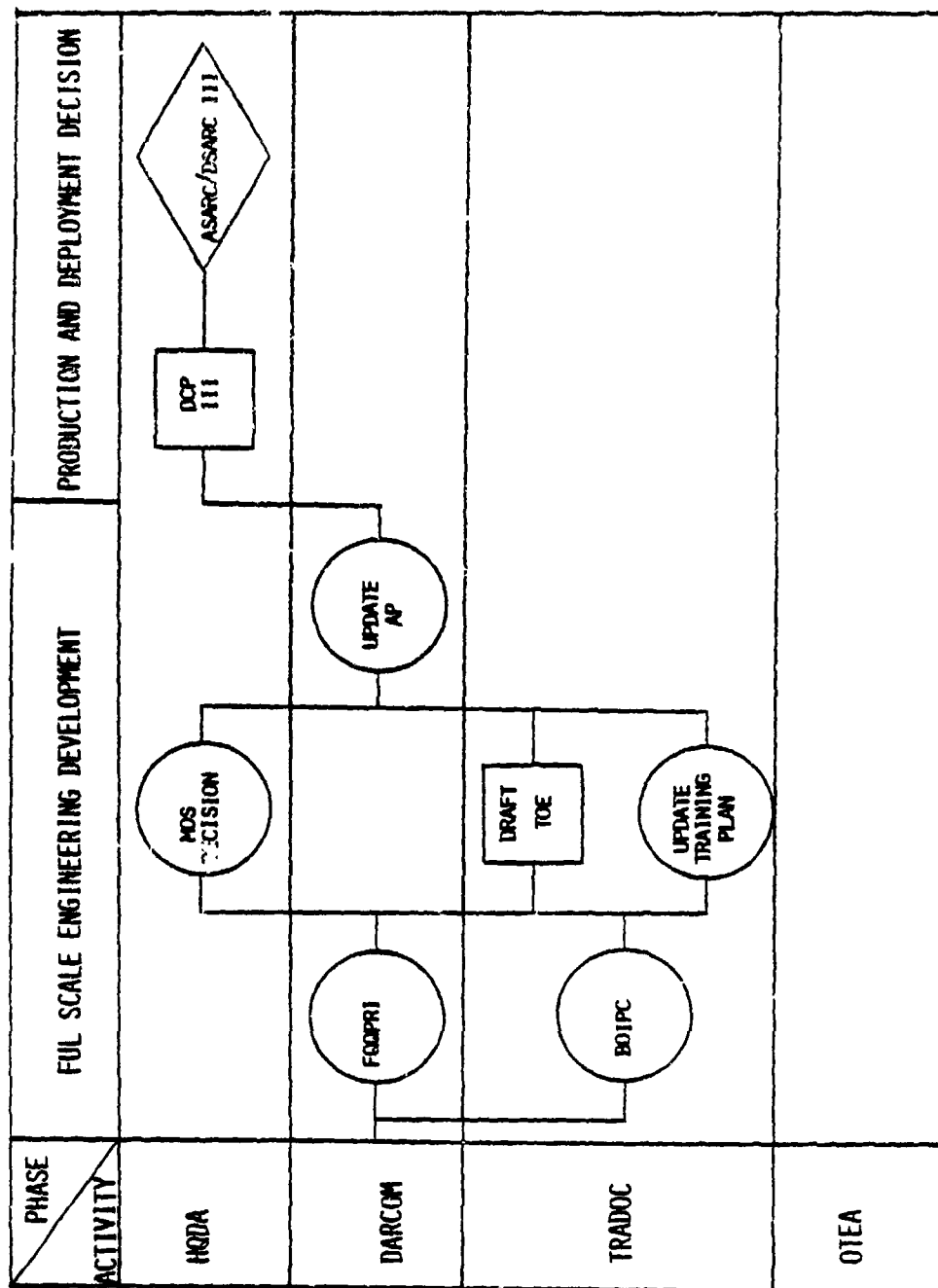


FIGURE 3-4. LIFE CYCLE SYSTEM MANAGEMENT MODEL (PART 11 OF 11)

DARCOM, prepares a MENS. The MENS will describe the operational task to be accomplished and will not be cast in terms of capabilities and characteristics of a hardware or software system.

3.3.3.2 Exploration of Alternative System Concepts Phase

The purpose of the second phase is to explore and identify alternative system concepts selected from all available sources. This exploration will generally be undertaken by a STF under DCSOPS direction or by a Special Study Group (SSG) chartered by CG, TRADOC. A Study Advisory Group (SAG) will generally be used in conjunction with an STF or SSG.

At the time of the materiel concept investigation, "personnel" is addressed only in very general terms. The TRADOC proponent may investigate at a very general level the impact of the materiel concept upon recruiting, MOS structure, training, and manpower authorizations. Questions such as the following must be asked and eventually answered:

- Can it reasonably be assumed that soldiers with the required mental and physical skills will be recruited and made available to operate and maintain the proposed system?
- Will current or future manpower authorizations support the system?
- What will be the impact on the current personnel structure?
- Will personnel trade-offs be required? What will be the effect on proposed system objectives?
- What is the human resources development impact of the proposed system?
- What cost-effective trade-offs are possible to capitalize on the human resources aspects for the system instead of materiel aspects?

When a concept has been formulated, the combat and training developers should begin planning the training/training device

requirements for the conceptualized system. These requirements can only be stated in general terms; however, the planning must proceed at the earliest possible time since training requirements can (theoretically) influence materiel design. The first element of the requirements is a Task and Skill Analysis (TASA), based on the concept of the materiel. The TASA should answer the question, "What is the best allocation of functions among operations, maintenance, and materiel?" Following the completion of the rough TASA, there should be an assessment of the general training/training device requirements.

A general statement of personnel requirements can then be addressed:

- Individual skills and skill levels required
- Estimate of the number of personnel required to operate and maintain the system
- Unique physical and mental considerations.

TRADOC, in coordination with DARCOM, prepares a Letter of Agreement (LOA) for HQDA approval. The LOA is the requirements document which supports the Demonstration and Validation (DVAL) phase.

Concurrent with the preparation of the LOA, the rough TASA is analyzed and subdivided into three categories: machine functions (or those which the developer believes could be best performed by the hardware), shared functions (man-machine interface), and purely human tasks. From the latter two categories, critical tasks are identified (as defined in TRADOC Pamphlet 350-30).¹⁶ These critical tasks are those most likely to require formal training and will serve as guidelines for developing the training support plan.

3.3.3.3 Demonstration and Validation Decision (Milestone I)

With the approval of the LOA, formulation of a system concept and an acquisition strategy is initiated. The Secretary of the Army charters a PM who reports through a DARCOM commodity command. OTEA is

¹⁶ TRADOC Pamphlet 350-30. Interservice Procedures for Instructional Systems Development. Fort Monroe, VA: 1 August 1975.

named as the operational tester, while DCSOPS issues force level guidance to the major commands.

The PM must identify to the proponent any organizational equipment, training, and personnel trade-offs that would be required if the system is added to the total force structure. This information will be used by TRADOC to develop, in coordination with the PM, the organizational and operational concepts which will be incorporated in the Concept Formulation Package (CFP) and also form the basis for the Provisional QQPRI and the first Basis of Issue Plan (BOIP).

Training support planning is focused toward considerations that will influence the design of the materiel and proposed training devices. These considerations may influence trade-offs required in later events. The basic document for planning is the outline Individual and Collective Training Plan (ICTP). As development progresses, the ICTP is updated and modified as needed. As more is known about system training requirements, the trainer develops plans for training methods, programs, and media; training devices; systems hardware for training; and scheduling requirements for training user and support personnel.

The CFP provides for the evaluation of alternative concepts and selection of the best concepts as a coordinated combat developer and materiel developer effort. The CFP consists of a Trade-off Determination (TOD), a Trade-Off Analysis (TOA), a Best Technical Approach (BTA), and a preliminary Cost and Training Effectiveness Analysis (CTEA) and Cost and Operational Effectiveness Analysis (COEA). The TOD is conducted by the PM and includes alternative personnel support concepts, together with the advantages and disadvantages of each, for each design alternative. Upon completion, the TOD is furnished to TRADOC. The TOA of the concepts identified in the TOD is conducted by TRADOC and is returned to the PM. The BTA is jointly prepared by TRADOC and the PM and describes the optimum contribution of an operational support concept for further development and evaluation during the validation and full scale development of the item. The CTEA/COEA is conducted by TRADOC and addresses the effectiveness of, among other things, the personnel support concept in terms of operational availability.

The PM, in coordination with TRADOC, OTEA, and LEA, will prepare an Outline Acquisition Plan (OAP), which presents the acquisition strategy through system demonstration and validation. The Organizational and Operational Concept (O&O), the Coordinated Test

Program (CTP), and plans for technical development, management, finance, personnel and training requirements, and logistic support.

In preparation for the DSARC decision to proceed with demonstration and validation, HQDA prepares the DCP I, the IPS I, and an Independent Parametric Cost Estimate (IPCE). The ASARC I formulates the Army's position for the Secretary of the Army's approval. The DSARC I formulates the DoD position for the Secretary of Defense's approval.

3.3.3.4 Demonstration and Validation Phase

Based on ASARC/DSARC I guidance, the OAP is updated by the PM in preparation for the award of Advanced Development (AD) contracts. The philosophy of OMB Circular A-109 calls for multiple awards to enhance cost-effectiveness through competition.

When the PM prepares the Request for Proposal (RFP), TRADOC must ensure that the proposed contracts contain the basic critical personnel criteria required for operation and maintenance. This includes the outputs from all previous investigations and events. The primary concern is development of hardware that the average soldier can effectively operate and maintain. Constraints based on previous personnel planning must be part of the contracts.

A specification of the Advanced Development contracts must be that the contractor(s) furnish as early as possible data for a TASA for each proposed operator and maintainer. Their analysis will be used for planning training requirements (updating ICTP), planning MOS requirements, and developing test issues for DT/OT I.

Using the contractor furnished TASA, TRADOC, in concert with the PM must determine critical tasks, evaluate training and training device requirements for the tasks, and make an initial estimate of whether the operator and maintainer will require new MOSs or modification of existing MOSs.

The documentation for the DT/OT I cycle is then prepared. The basis for testing is the CTP of the OAP. It is structured to ensure tasks associated with the hardware are tested and/or evaluated. These include all operational, maintenance, and support tasks that are required to make the system effective. Each task must be identified and an estimate made for the time required for performance. The man-machine interface of mental and physical requirements for the soldier

expected to operate and maintain the system must be tested also. TRADOC prepares the personnel support input to the TSP and forwards it to the PM to be used in the preparation of the DT TDP and to the test organization to be used in the preparation of the OT TDP.

After DT/OT I has been completed and the test reports prepared, the proponent, in coordination with the PM, must evaluate the results. The operation and maintenance task lists must be reviewed and verified. The personnel criteria that were specified in the test issues should be reviewed and revised if necessary. From the preceding actions, the outline training plan can be updated, the issues for further test developed, and the basic information for an updated QQPRI accumulated.

The DARCOM NET element and TRADOC refine training requirements for operator and logistic personnel based on the outputs of DT/OT I and any other new personnel training requirements determined in previous or ongoing investigations. They also analyze technical documentation to determine personnel and training impact and plan participation in, and attendance at, the staff planners course, the technical orientation course, and the instructor and key personnel course. The updated training planning will be documented by the materiel developer and should include a description of training devices, training methods and media, training extension courses, soldiers and commanders manuals, skill qualifications tests, ICTP material, field manuals, and other requirements necessary to provide for individual and unit training.

DARCOM elements will revise the QQPRI and send it through US Army Materiel Readiness Support Activity (MRSA) to TRADOC. The TRADOC approved QQPRI input will be returned to MRSA for further action and forwarding to MILPERCEN.

Initial unit structures are revised by TRADOC proponent schools/agencies using combat developer studies, QQPRI, and BOIP feeder data. The DARCOM proponent command provides feeder data through the Equipment Authorization Review Agency to TRADOC, who will task the proponent school to revise the BOIP to reflect any changes.

TRADOC will conduct a COEA of the system. As part of this effort, a CTEA will be conducted on the training subsystem.

The materiel developer is responsible for the initiation, development, and publication of the NET Plan. TRADOC will assist by

providing input as applicable to MOS training prior to formal review/update at the Training and Support Work Group (TSWG) meetings. TRADOC schools will actively participate (throughout the life cycle) in the DARCOM sponsored TSWGs. DARCOM will prepare elements of the ICTP for which it has functional responsibility and forward it to TRADOC for inclusion in the ICTP. The designated TRADOC proponent develops the respective individual and collective training plans based upon QQPRI, task analysis, CTEA, and materiel developer input. In addition to milestone schedules, the ICTP should include training concepts, estimated training class quotas by MOS and skill levels, a description of required training literature, training extension course listings, audio-visual media, simulators, training devices, and hardware requirements for conducting institutional instruction.

TRADOC is responsible for the development of the Required Operational Capability (ROC). The ROC will include a personnel assessment that will identify personnel considerations which have an impact on further full-scale development of the materiel system and personnel support. TRADOC will ensure that the ROC includes:

- Personnel interface with existing and projected equipment
- Training and training device requirements
- Desired system safety and human engineering characteristics.

The STF or SSG may be reconvened to review the progress of the program in preparation for the next DSARC decision.

A MIRAT Plan is prepared by MILPERCEN and coordinated with the Recruiting Command.

The PM prepares the Acquisition Plan (AP) in coordination with TRADOC. The AP presents the acquisition strategy through FSED. The AP should include identification of new skills, individual and crew training requirements. Skill Performance Aids (SPA), training devices, training facilities, and associated schedules.

2.3.3.5 Full-Scale Engineering Development Decision (Milestone II)

In preparation for ASARC/DSARC II, a DCP II, IPS II, and an updated IPCE are prepared. The Secretary of Defense's approval initiates the Full-Scale Engineering Development (FSED) phase.

The PM prepares for future production by Producibility Engineering and Planning (PEP) and a Manufacturing Methods and Technology Program (MTP).

2.3.3.6 Full-Scale Engineering Development Phase

FSED is initiated with the award of the Engineering Development (ED) contract. While the ED model is being developed, DT/OT II is revised and refined planning begins. Major emphasis is placed on demonstrating during the DT/OT II phase that all key criteria which have been established for the system can be satisfied, including training requirements and personnel supportability. DT II must be carefully planned to provide an adequate assessment of training and personnel and minimize associated risks. OT II must validate the suitability of personnel support and training (to include training devices). The operational tester prepares a TDP which identifies the test objectives for materiel being tested during OT II. Personnel input to the TDP will provide for a comprehensive evaluation of system supportability, doctrine, organizational procedures, and user training in accordance with the approved personnel support concept. TRADOC provides test issues, associated criteria, and the combat developer/trainer test support packages to the test organization. The package includes statement of organization and basis issue, training plan, and statement of personnel support concepts. Action must be taken to identify and stabilize personnel for the test.

Instructors, schooled by a selected contractor, will train key operator and support personnel for the conduct of OT II using the TRADOC-approved training program to be implemented when the system is approved for deployment. Normally, SPA materiel should be available for their training also.

Following completion of DT/OT II, the responsible test agency prepares test reports. These reports contain the data obtained and the conditions which actually prevailed during test execution. The test reports also contain an analysis of the personnel test results versus the personnel test objectives. OTEA prepares an IER based upon the OT report, studies and other appropriate sources, to include the OT report. When determining the military worth of the equipment personnel aspects as well as operational aspects are considered. Potential personnel problems, training, organizational and doctrinal implications, and the impact of fielding or not fielding the equipment are some of the factors considered. The IER, together

with test reports and supporting documentation (comments from other agencies, etc.), are provided to the DSARC/ASARC members at least two weeks prior to the preliminary review. The data contained in these documents should assist the decision makers in reaching a valid and reasonable decision.

The final QQPRI is developed by the materiel developer approximately thirty months prior to scheduled deployment of new materiel items. Some considerations of the proponent school/agency, while coordinating with other interested schools/agencies, are:

- Are all system components and subcomponents identified and listed in QQPRI documentation, to include MOS and annual maintenance man hours for each level of maintenance?
- Is the MOS proper to support equipment in the proposed Table of Organization and Equipment (TOE)?
- Are skill levels correct for the MOS and expertise required?
- Will training be sufficient to provide required expertise?
- Will there be a sufficient number of MOS trained personnel in the field to support the equipment?

Based on data from OT II, the proponent makes any changes in the unit structure for the new system and incorporates them into the BOIP. Normally, an update of BOIP includes planned changes in other equipment and in personnel necessary to accommodate new items of equipment.

TRADOC will continue to update training planning to validate personnel training requirements. The training plan will be expanded and revised in preparation for initiation of resident training. Test reports of DT I/OT I, DT II/OT II will be used to provide information on the use and effectiveness of training personnel. If not previously provided, proponent schools will take action to obtain logistical support analysis requirements (LSAR) output summary sheets from the materiel developer. Draft equipment publications, LSAR summaries, and

field manuals will be evaluated to ensure correlation of training with personnel support doctrine and organizational structure of support units. This update training plan will be evaluated during OT II or III, if these tests are required.

The PM, in coordination with TRADOC, updates the AP in preparation for the final ASARC/DSARC review.

SECTION IV AUDIT TRACE

This section contains a detailed history of the development of the personnel and training subsystems of the XM1 Abrams Tank System from program inception to ASARC III. Events outside the domain of personnel and training are included only to the extent that they are required for an understanding of personnel and training. This section is intended to be as objective and factual as possible; analysis is studiously avoided to the extent possible. Analysis and conclusions are to be found in subsequent sections.

The XM1 Tank System was chosen for this case study because it is a high visibility, major system in the initial production stage. Its many accomplishments to date make it one of the Army's most successful development efforts.

It is in the nature of "lessons learned" case studies to concentrate on the errors and shortcomings of the subject system. As a result they tend to paint a somewhat gloomier picture of the system than may be necessary. This is particularly the case with this study, since it focuses on areas where XM1 is weakest. The reader should be cautioned to remember the essential success of the total system while reading this report.

4.1 THE DEVELOPMENT CYCLE

For the period to be considered by this study, the standard Life Cycle Systems Management Model (LCSMM) can be divided into eight phases, as shown in the left-hand column of Figure 4-1. Because of compressed development of XM1, the first four phases have been combined into one, as shown in the right-hand column of Figure 4-1. For the purpose of this study, both the Demonstration and Validation (DVAL) Phase¹ and the Full-Scale Engineering Development (FSED) Phase have each been subdivided in two subphases. The Contract Award and Test Subphase contains those events concerned with the development and evaluation of contractor-provided items. The Planning Subphase is concerned with events oriented toward personnel, training, and support planning.

¹ Also known as the Advanced Development (AD) Phase

STANDARD LCSMM	XM1 DEVELOPMENT
CONTINUING ANALYSIS OF MISSION AREAS	CONCEPT FORMULATION
PROGRAM INITIATION (MILESTONE 0)	
EXPLORATION OF ALTERNATIVE SYSTEM CONCEPTS	
DEMONSTRATION AND VALIDATION DECISION	
DEMONSTRATION AND VALIDATION	ADVANCED DEVELOPMENT A. CONTRACT AWARD AND TEST B. PLANNING
FULL-SCALE ENGINEERING DEVELOPMENT DECISION	FULL-SCALE ENGINEERING DEVELOPMENT DECISION
FULL-SCALE ENGINEERING DEVELOPMENT	FULL-SCALE ENGINEERING AND DEVELOPMENT A. CONTRACT AWARD AND TEST B. PLANNING
PRODUCTION DECISION	PRODUCTION DECISION

FIGURE 4-1. DEVELOPMENT CYCLE

4.2 CONCEPT FORMULATION PHASE

4.2.1 MBT70/XM803 Programs

During the early 1960s the Army recognized the requirement for a new main battle tank (MBT) to succeed the M60 series tanks. A joint program with the Federal Republic of Germany (FRG) was established in 1963 to develop the MBT70. General Motors Corporation (GMC) was selected as the contractor for the American version and several prototypes were built. Mounting conflict between the American and FRG approaches led to the abandonment of the joint effort. A totally American approach was then formulated as the XM803, while the FRG developed the Leopard 2.

The MBT70/XM803 was to be a significant technological improvement over the M60. Armed with a 152mm weapon, it would fire both the Shillelagh missile and conventional ammunition.² The tank was to be diesel powered with a very sophisticated hydropneumatic suspension system. Equipped with an automatic loader, the tank required only a three-man crew as opposed to the M60's four.

Although sometimes referred to as the Army's "dream tank," it was in fact a cause of great controversy both within and without the Army. Many armor officers disliked the gun-missile system and considered the three-man crew inadequate for sustained operations. Within the military and in the Congress there were many saying that the advent of anti-tank guided missiles (ATGMs) had made the tank obsolete. The controversy, combined with the high costs, impelled Congress to cancel the XM803 in December 1971, with instructions to try again on a more realistic basis.

4.2.2 Main Battle Tank Task Force

The new program, designated the XM1 Tank System, began in January 1972 with the appointment of a Department of the Army System Staff Officer (DASSO) for XM1 in the Office of the Chief, Research

² This gun-missile weapon was first introduced on the M60A2, a product improvement of the M60. The M60A2 encountered many performance problems and was generally very unpopular among armor officers.

³ Now known as the Department of the Army System Coordinator (DASC), assigned to the Deputy Chief of Staff for Research, Development, and Acquisition (DCSRDA).

and Development (CRD). The Chief of Staff, Army (CSA), General Creighton W. Abrams, established the Main Battle Tank Task Force (MBTTF) to define the requirements for the new MBT.

In order to comprehend the history of the XM1 it is necessary to understand the pressures under which the developers operated during program initiation. There was a feeling, expressed most forcefully by General Abrams, that the Army had "struck out twice" with the MBT70 and the XM803 and that the XM1 would be the Army's last chance for a new MBT. It was felt that, if the XM1 were to be a success, several steps must be taken. First, the Army must avoid the public airing of internal debates over the design to avoid "shooting itself in the foot." Second, the tank needed to be developed and fielded quickly as much time had been lost in encountering the expanding Soviet threat during the abortive MBT70/XM803 phase. Third, costs must be kept within bounds; the new tank was not to be the best that money could buy, but the best that the Army could afford. There⁴ was particularly strong Congressional pressure for the last two steps.

The vehicle for initiating these steps was the MBTTF, which was convened in February 1972 at Fort Knox, Kentucky. The task force's mission was to analyze the Army's requirement for a new MBT and develop a realistic plan for meeting it. An Engineering Development Materiel Need (MN(ED)) was to be a requirements document that the entire Army could rally around. A philosophy and set of goals for the acquisition program was to be established in a Development Concept Paper (DCP)⁵ for approval by the Secretary of Defense (SECDEF).

The MBTTF contained thirty-three representatives from all of the key agencies in the acquisition process, including CRD,⁶ the

⁴ According to a contemporary member of the Army Staff in the Office of the Assistant Vice Chief of Staff, Army (AVCSA) during interviews by the study team. Quotes attributed to GEN Abrams by the same source.

⁵ Now known as the Decision Coordinating Paper (DCP).

⁶ Now known as DCSRDA.

Assistant Chief of Staff for Force Development (ACSFOR),⁷ the Combat Developments Command (CDC),⁸ the Continental Army Command (CONARC), and the Army Materiel Command (AMC). The MBTTF developed several key acquisition documents normally created by the participating agencies; Figure 4-2 shows the documents and the normally responsible agencies.

The task force initially developed eighty-seven tank configurations for analysis. The AMC commodity commands provided catalogues of components; from these seventy-two configurations were created. Input from defense contractors provided eleven more. The other four versions were product improvements of the M60 tank. From these eighty-seven, five were selected to be included in the Best

<u>DOCUMENT</u>	<u>RESPONSIBLE AGENCY</u>
1. Draft DCP	CRD
2. Training Device Requirements (TDR)	CONARC
3. Preliminary Qualitative and Quantitative Personnel Requirements Information (PQQPRI)	AMC
4. Unit Structure (Tentative Basis of Issue)	CDC
5. Force Level Guidance	ACSFOR
6. Coordinated Test Program	AMC
7. MN(ED)	CDC

FIGURE 4-2. DOCUMENT REQUIREMENTS FILLED BY THE MBTTF

- ⁷ Duties now assigned to the Deputy Chief of Staff for Operations and Plans (DCSOPS).
- ⁸ Duties now assigned to the Training and Doctrine Command (TRADOC).
- ⁹ Now known as the Materiel Development and Readiness Command (DARCOM).

Technical Approach (BTA): Two versions by the Tank-Automotive Command (TACOM), based on component catalogues; one version each from General Motors Corporation and Chrysler Corporation; and one M60 with all possible product improvements (the so-called "M60AN"). The study analysis had included threat, survivability, firepower, mobility, and cost.

The task force established a development philosophy intended to meet Congressional objections and maximize the probability of funding. This philosophy consisted of three major points:

- (1) Increased contractor responsibility for total system integration and characteristics trade-off
- (2) Competitive prototypes in Advanced Development (AD)
- (3) Recognition that costs must be limited.

The increased contractor responsibility for system design was in response to the feeling, especially in Congress, that the arsenal-centered approach stifled innovation.

"In the past, we just sort of fitted the pieces together. There was no real, from-the-ground-up thought process. Development has been dictated by an in-house philosophy that rejected the idea that industry should have a part in this."¹⁰

As a result, the contractor was to be given a set of desired characteristics stated in terms of allowable maxima and minima within which the designer was encouraged to trade-off.¹¹ To aid the designer, priorities for design characteristics were established, as shown in Figure 4-3.

¹⁰ Major General Robert J. Baer, quoted in Eric C. Ludvigsen, "XM1 Face-off to Have Strong Impact on Future Ground Forces," Army Magazine, February 1976, pp. 32-35.

¹¹ As might be expected, this was to cause some difficulties. Throughout the program, designer innovations were resisted by many traditionally-minded elements in the development community.

1. Fire Power
2. Mobility
3. Crew Survivability
4. Reliability, Availability, Maintainability (RAM)
5. Cost
6. Weight
7. Equipment Survivability
8. Improvement Potential
9. Human Engineering
10. Transportability
11. Compatibility with Associated Equipment

FIGURE 4-3. XM1 DESIGN CHARACTERISTICS IN ORDER OF PRIORITY (ADVANCED DEVELOPMENT)

In order to ensure the maximum amount of contractor effort for the least cost, it was decided that there should be at least two AD contracts awarded with a "shoot-off" among the prototypes at the end of the AD phase. This was an adaptation of the Air Force's "fly before you buy" approach to procuring aircraft. GMC (developer of the MBT70/XM803) and Chrysler (builder of the M60 series tanks) were the two most likely candidates.¹²

In order to ensure Congressional funding, three major development goals were established:

¹² The combination of increased contractor responsibility for design and multiple AD contract awards implied that the contractor designs would be very competition sensitive. As a result, in order to protect proprietary information, the Government was forced to isolate itself to a significant degree from the AD contractors. This in turn delayed some critical aspects of in-house integrated logistic support planning until FSED nearly five years later.

- (1) Significant improvement over the M60 in survivability, fire power, and mobility¹³
- (2) Production models to be produced within seven years of initial development
- (3) Production unit cost to be less than \$507,790 (FY72 dollars).

These last two goals were to become the driving forces behind the program.

The personnel and training considerations for fielding a new MBT were prepared by the US Army Armor School (USAARMS).¹⁴ They were limited to statements that there were to be no new major changes to the training system and if any new types of systems were to be fielded, new system training must be provided.

Several key manpower decisions were made or implied by the MBTTF. The XM1 was to have a four-man crew,¹⁵ based on the requirement for sustained operations and technical difficulties with automatic loaders. There was to be a one-for-one replacement of M60s by XM1s with no increase in either the quantity or the quality of crew or logistic support personnel.

¹³ But what constituted "significant improvement" was never made very explicit.

¹⁴ Activities now conducted by the US Army Armor Center (USAARMC).

¹⁵ As opposed to the three-man crew and automatic loader of the MBT70/XM803 and the current Soviet MBT, the T-72.

The MBTTF completed its work and issued a final report in August 1972. An after-action report appeared in September 1972.¹⁶

4.2.3 Demonstration and Validation Decision

In July 1972, while the MBTTF was concluding its study, DA approved a Project Manager (PM) charter for XM1. The first PM XM1 was appointed and established the Project Management Office (PMO) at TACOM in Warren, Michigan. Work began on the AD Request for Proposals (RFP).

In August, the Secretary of Defense determined that the Secretary of the Army would be the Source Selection Authority. The Secretary of the Army in turn appointed a Source Selection Advisory Council.

The draft DCP was reviewed at HQDA, with special interest by General Abrams, and revised. The Proposed DCP was approved by HQDA in October 1972. HQDA approved the MN(ED) in November 1972.

The Army Systems Acquisition Review Council (ASARC) I and the Defense Systems Acquisition Review Council (DSARC) I met in October and November 1972, respectively, and approved entering into the Contract Definition Phase.

On 18 January 1973 the Secretary of Defense approved the DCP. The program was now fully initiated and the PM XM1 had seven years to begin production.

¹⁶ MBTTF, MBTTF Final Report(U), Fort Knox, KY: 1 August 1972.
(SECRET RESTRICTED DATA)

1. Executive Summary (U)
2. MN(ED) (U)
3. COEA (U)
4. Threat (U)
5. Parametric Cost Analysis (U)

MBTTF, After-Action Report (U), Fort Knox, KY: September 1972.
(CONFIDENTIAL)

¹⁷ Now part of the Demonstration and Validation Phase.

4.3 DEMONSTRATION AND VALIDATION: CONTRACT AWARD AND TEST

4.3.1 Source Selection

The RFP for AD prototypes was released on 25 January 1973. GMC and Chrysler were considered to be the most likely candidates to bid.¹⁸ Chrysler, as the builder of the M60 was anxious to respond. GMC, on the other hand, did not care to participate after its experience with the XM803; only after intense pressure from the highest echelons of the DoD did GMC consent.¹⁹ There were no other responses.

In March the PM produced a Source Selection Evaluation Plan and CG, DARCOM appointed a Source Selection Evaluation Board (SSEB). Both Chrysler and GMC were selected for AD contract awards on 29 June. Meanwhile, the PM had issued the Development Plan (DP).²⁰

The AD contracts did not call for the contractors to develop Integrated Logistic Support (ILS) packages for evaluation at DT/OT I. The rationale for this decision was that cost savings could be effected. It was reasoned that, since only one of the two prototypes would be selected for Full Scale Engineering Development (FSED), there was no point in purchasing two AD ILS packages. Only the minimum amount of material needed to accomplish DT/OT I would be purchased from each contractor. ILS development was to be postponed until FSED.²¹

GMC and Chrysler proceeded in their development efforts. Following the development philosophy established by MBTTF, the

¹⁸ Ford Motor Company reviewed the RFP, but did not respond.

¹⁹ As reported in an interview by the study team with a contemporary member of the AVCSA staff. There seems to be general agreement that, once in the competition, GMC spared no effort to win.

²⁰ Now known as the Acquisition Plan (AP), this document was frequently updated through the life of the project.

²¹ This decision is contrary to the requirements of AR 1000-1 and the DARCOM Supplement to AR 700-127. Ramifications of the decision will be discussed throughout this audit trace.

Government pursued a "hands-off" approach during the AD phase. The contractors were relatively free to design their prototypes as they saw fit. Because of the highly competitive nature of the impending FSED procurement, the Government virtually sealed itself off from the two proprietary designs.²²

PM XM1 originally intended to use an adapted version of the tank thermal sight (TTS) developed by Texas Instruments (TI) for the M60A1E3.²³ Negotiations with TI were unsuccessful and a new development effort was initiated. This caused a delay of approximately three years in the TTS. As a result, night vision questions were not addressed during AD.

Contractor ballistic testing took place on schedule January-April 1974. Contractor cost estimates for production were delivered in June 1974 and April 1975. Materials for testing (including prototype vehicles) were delivered on schedule between October 1975 and February 1976. GMC and Chrysler both submitted proposals for FSED in February 1976.

In external appearance, both the Chrysler and GMC versions were similar, being longer and lower than the M60 series with about the same ground clearance, but without the commander's cupola. Both prototypes were fitted with the M68 105mm main gun which, with the turret drive, is stabilized and slaved to the gunner's line of sight; the net effect is that the gun is continually aimed where the gunner is looking. Both systems incorporated laser range finders and ballistic computers. Both tanks were outfitted with the new Special Armor.²⁴ Figure 4-4 shows some comparative data among the Chrysler XM1, GMC XM1, and the M60A1.²⁵

²² There is some feeling in the TRADOC community that this impeded the development of the personnel and training subsystems.

²³ Now known as the M60A3. Occasionally referred to as the Product Improved M60A1 or the M60(PI).

²⁴ Special Armor, details of which are highly classified, is a major technical advance over the MBT70/XM803 approach; but it is rather heavy compared to conventional armor, thus necessitating weight saving in other areas.

²⁵ Source: Ludvigsen, op. cit., p. 35.

In the Chrysler version there is a vertical slimming of the hull accomplished by adopting a semi-reclining position for the driver when the tank is buttoned up.²⁶ When the hatch is open the contour-padded seat and motorcycle-type controls return to an upright position.

The Chrysler prototype was powered by a 1500 hp AVCO-Lycoming AGT-1500 turbine engine. Recognizing the high risks associated with developing a turbine engine for a tank, Chrysler believed that it offered significant advantages in reliability and maintainability and that it would be less costly to operate in the long run, even though it would be less fuel efficient than a diesel. Use of the turbine saved about 1700 pounds of weight which was used for additional armor. The turbine also offered the potential for a reduction in noise and smoke signatures.

	<u>Chrysler Prototype</u>	<u>GMC Prototype</u>	<u>M60A1</u>
PERFORMANCE			
Maximum Speed	45 mph	48 mph	30 mph
Cross-Country Speed	35 mph	*	12 mph
Acceleration, 0-20 mph	7 sec.	*	12.2 sec.
Vehicle Obstacle Ability	42 in.	36 in.	36 in.
Trench Crossing Width	108 in.	90 in.	102 in.
Operational Range (at 30 mph)	300 miles	*	310 miles
WEIGHT & DIMENSIONS			
Combat Loaded Weight	58 tons	58 tons	54.8 tons
Turret Roof Height	92.5 in.	95 in.	106 in.
Chassis Length	307 in.	300 in.	273.5 in.
Width	140 in.	144 in.	143 in.

*Not available

Source: Army Magazine, February 1976.

FIGURE 4-4. COMPARATIVE DATA: CHRYSLER XM1, GMC XM1, M60A1

²⁶ In order to avoid controversy the PMO had previously arranged for Armor Center review of this feature during AD; the Armor Center found the position acceptable.

GMC's version opted for a 1500 hp Teledyne-Continental AVCR-1360-2 diesel engine. This decision was based primarily on design and schedule risks. The GMC version employed the XM-1100-1A automatic transmission (as did Chrysler) manufactured by GMC's subsidiary Detroit Diesel Allison.

Both designs sought to improve the operation time to maintenance time ratios. The objective was a 1:1 ratio as opposed to the M60 series 1:2-2 1/2.

4.3.2 DT/OT I

In order to save time and money, a combined DT/OT I was proposed by the PM XM1 and supported by the Developmental Tester, (US Army Test and Evaluation Command (TECOM)), and the Operational Tester (US Army Operational Test and Evaluation Agency (OTEA)).²⁷ The test was intended primarily as a "shoot-off" between GMC and Chrysler.

The initial program schedule called for TECOM and OTEA to produce an Outline Test Plan (OTP) in April 1973, but was delayed until October. A Coordinated Test Plan (CTP) was issued by the PMO in May 1974. The CTP established the critical issue:

"The single most critical technical issue to be resolved through testing during the validation phase of the XM1 development program is whether or not the proposed XM1 evidences a capability, upon completion of development, for demonstrating performance which exceeds that of the product improved M60A1 tank, the M60A1E3."²⁸

This critical issue was divided into five critical sub-issues, shown in Figure 4-5.²⁹

²⁷ Combining DT and OT is not unusual at this stage of project development. It does, however, eliminate the opportunity to correct engineering problems discovered at DT prior to OT.

²⁸ PMO XM1, XM1 Tank System Coordinated Test Program (CTP), Warren, MI, 29 May 1974. Section IV, Paragraph 1.0.3.1

²⁹ Source: Ibid.

Survivability. Does the potential survivability afforded by the competing prototypes exceed that of the M60A1E3 in terms of armor protection (HE & HEAT), mine protection, compartmentalization of fuel and ammunition, anti-spall techniques and multi-hit protection?

Firepower. Does the potential firepower system performance of the competing prototypes exceed that of the M60A1E3 with respect to surveillance and target acquisition performance (day only), first and subsequent round hit probabilities, and time to hit and kill? (Include all modes of stationary and moving tanks and targets). (Note: Night performance will not be tested during DT I/OT I.)

Mobility. Does the potential mobility performance of the competing prototypes exceed that of the M60A1E3 with respect to cross-country mobility, acceleration (forward and reverse), operation on ten percent and sixty percent slopes, maximum sustained speeds? Integral to this issue is the impact of mobility on crew survivability. That is, does the XM1 mobility make it a more difficult target to acquire and hit?

RAM-D. Does the available information accumulated by the end of DT I/OT I indicate a capability to achieve eighty-five percent of the RAM values at the end of FSED and one hundred percent of these values in production?

FIGURE 4-5. CRITICAL SUBISSUES FOR XM1 DT/OT I. (Part 1 of 2)

Although not entirely quantifiable, the fightability of the XM1 prototypes must be assessed during DT I/OT I. Evaluation of fightability will entail a human engineering assessment of the crew stations to insure that crew functioning has been included as a key design parameter in the design approach. Examples of this include accessibility of ammunition and controls, servicing of weapons, design of the driver's station, ease of maintenance by both crew and technicians, etc. Of necessity, this assessment will require military judgment based on experience as well as an analytical evaluation of the design. The night fighting capabilities of the XM1 prototypes will be assessed to the limits imposed by hardware availability.

Included in each sub-issue is the implicit requirement to identify, if possible, the "best" candidate with respect to that issue.

FIGURE 4-5. CRITICAL SUBISSUES FOR XM1 DT/OT I. (Part 2 of 2)

Source: XM1 CTP, May 1974, Section IV, Paragraph 1.0.3.1

Several points can be observed. First, while the criteria calls for the XM1 to exceed the performance of the baseline, it fails to say by how much. Second, XM1 is required in DT/OT I only to evidence a potential; no criteria are established for this. Third, the baseline tank is clearly established as the M60A3.

Preliminary planning began in July 1974, with TECOM and OTEA submitting final draft test plans in April 1975. The test plans reiterate the issues of the CTP, including the use of the M60A3 as the baseline. It is already recognized that adequate RAM data will not be forthcoming from DT/OT I, but will have to wait until DT/OT II.

"The contractor is responsible for maintenance on test items except for scheduled and noncomplex maintenance which may be performed by government personnel. Due to the exceptional skill levels of maintenance personnel, limited sample size and test duration, the reliability, availability, and maintainability (RAM) data accrued will not be adequate for statistically meaningful results, however, all available RAM data will be forwarded to the Project Manager's Office (PMO) for evaluation along with an objective and subjective TECOM narrative evaluation of RAM-D based upon this data. The PMO will use these data and the data from contractor tests to publish both objective and subjective portions of the RAM evaluation. This will include whether the available information accumulated by the end of DT/OT I indicate a capability of achieving the requirements of the next test phase (DT/OT II)."³⁰

The combined DT/OT I took place on schedule 7-30 April 1976 at Aberdeen Proving Grounds, Maryland. Each competitor provided one candidate XM1 tank and one automotive test vehicle. Two M60A1A0S

30

W. C. Kietzman, et. al., Developmental Test I of XM1 Tank System
(U): Test Plan Final Draft, USATECOM, Aberdeen Proving Ground,
MD: April 1975 (SECRET), p. 3.

tanks were used as the baseline.³¹ Figure 4-6³² shows the test objectives and limitations. It should be noted that the objectives call only for information.

Following a 30 June 1975 General Officer In-Process Review (IPR) concerning crew selection for DT/OT I, selection criteria guidelines were developed by the US Army Armor Center. Eleven armor crew members from Fort Knox and nineteen armor crew members from the First Cavalry and Second Armored Divisions were selected. Above average crew members were used to preclude obscuration of system performance by crew effect.

The training for the XM1 DT/OT I was conducted in three distinct phases: baseline phase, transition phase, and refresher phase. USAARMS provided a Training Evaluation Team (TET) to observe and evaluate contractor transition training.

Baseline training on the M60A1AOS was conducted at Fort Knox during the period 4-19 December 1975. The Program of Instruction (POI) allotted three days to automotive training, seven days to weapons training, and one day to command and control. Diagnostic testing was conducted prior to firing the subcaliber tables in order to establish the level of individual proficiency. Initial structuring of crews was accomplished during this phase. Based on the results of performance examinations and range firing, there appeared to be no statistically significant difference among the test crews. Test crews and spare personnel were deemed qualified to participate in the DT/OT I for the XM1 tank.

Transition training was conducted by the contractors during the period 10-24 January 1976. Cross-trained crews received training on both XM1 candidates while the four remaining crews were dedicated to one candidate or the other. The six spare crew members were trained as follows: two each to both candidates, two each to the General Motors candidate, and two each to the Chrysler candidate.

³¹ The study team was not able to trace how the decision was made to substitute the M60A1AOS for the M60A3 as the baseline vehicle. A similar situation will arise for OT II.

³² Source: USAOTEA, New Army Battle Tank (XM1) Operational Test I (U) (Short Title: XM1 OTI), FTR-OT-031. Falls Church, VA: May 1976. (CONFIDENTIAL) p. ii.

Test Objectives

Objective 1. Provide information to assess the potential operational effectiveness of the two candidate systems in terms of firepower and mobility with emphasis on the man component of the system.

Objective 2. Provide information from which insights as to the operational survivability of the two candidate systems may be gained.

Objective 3. Provide information relative to the adequacy of proposed personnel qualifications, training, and selection criteria.

Objective 4. Provide information on crew level maintenance and system failures.

Test Limitations

a. The terrain available for tank maneuvering at Aberdeen Proving Ground is extremely limited.

b. The narrow range fan (8 degrees) established for H-Field limited target placement and methods of engagement.

c. With the exception of the driver's hatch, all firing engagements had to be conducted from the open hatch mode. This limitation was imposed as a safety factor due to the restrictive range fan at H-Field.

d. The extremely short period (15 days) severely limited both the amount and depth of testing that could be conducted.

e. Night firing exercises could not be conducted because night vision equipment was not available on the candidate vehicles for OT I.

f. The use of contractor maintenance support limited the amount of operationally relevant maintenance data which could be gathered.

g. Safety restrictions prohibited the use of the laser range-finder at the Perryman test site. For this reason a comparison of ranging capabilities of the candidates to the baseline was precluded.

h. The safety release did not permit operation of the test vehicles at speeds greater than 40 MPH. This impacted on the mobility runs which were conducted at the Churchville test site.

i. The safety release did not permit firing the candidate vehicles over the back deck as specified in the Test Design Plan.

FIGURE 4-6. OBJECTIVES AND LIMITATIONS

Due to the length of time between transition training and the actual test, a refresher training program was administered during the period 3-15 April 1976. Refresher training consisted of a review of the initial training program and added instruction to cover systems modifications made in the interim time frame. Firing exercises, including participation in developmental test firing programs, were accomplished to refamiliarize participating crews with the candidate systems.

The training phase was followed by the field exercise phase which was conducted during the period 9-30 April 1976. Subtests were conducted in target acquisition, operational firing, mobility, compatibility, agility, signature/detectability, and maintenance. A substantial number of human factors observations and comments were obtained through questionnaires, interviews, and checklists.

The test included analyses of the adequacy of training and personnel selection. In general the GMC training package seemed definitely superior to Chrysler's; Figure 4-7³³ presents some comments from the OT I report comparing the two. The TET concluded that there was a valid requirement for a full crew interaction simulator (FCIS) and/or a conduct of fire trainer (COFT), but that a sophisticated driver trainer did not seem to be necessary; other available tank training aids seemed to be adequate.³⁴

At the conclusion of the test both competitors were deemed to be acceptable.

4.4 DEMONSTRATION AND VALIDATION: PLANNING

4.4.1 The Tank Special Study Group

User requirements for the XM1 had been established by the MBTTF in 1972. Several events over the next two years pointed up the need to review and revalidate these requirements. First, the 1973 Yom Kippur War provided a new base of experience for evaluating the role of the tank on the modern battlefield; successful Egyptian employment of ATGMs against Israeli tanks had again raised doubts about the

³³ Source: Ibid., pp. 145-149.

³⁴ Ibid.

DATA REQUIREMENT	HOW ADDRESSED	GMC PERFORMANCE	CHRYSLER PERFORMANCE
1. Determine if contractor POIs could effectively transition an M60A1A0S crew-member to XM).	Observation by TET of contractor transition training.	Program well designed with maximum effective use of resources. Exercises progressive in difficulty, designed to allow crews to learn as much as possible within time avail	Training was "somewhat" loosely structured" and did not provide a smooth flow from one subject to another. Non-concurrent training resulted in 1 week lost training time for devices. Handouts were limited. Exercises were not progressive.
2. Determine if contractor training publications adequately supported transition training during on-vehicle operations.	Observation of trainees use of publications, primarily operator's manual and crew-member's pocket manual.	Publications were indexed by crew-member's area of responsibility, easy to use to rapidly locate information. Generally clear and understandable, appear to be innovative and of benefit to the user.	Manual formatted by functional area, required more time to use and general in descriptive requirements. "Usable."
3. Determine if MOI's were effective and in accord with accepted military instructional methodology and techniques.	TET observation of training and review of trainees' evaluations.	Instructors were well prepared and rehearsed and followed accepted MOIs.	Instructors were "somewhat informal" and did not always follow accepted military MOIs resulting in contradiction and confusions. Modifications were required
		Both documents contained numerous technical errors and will require complete editorial review.	Both programs appear to impart required skills, but were too technical and above the student audience.

FIGURE 4-7. COMPARISON OF CONTRACTOR TRAINING PROGRAMS DURING DT/OT I

Source: XM1 OT I Report, May 1976, pp 145-149.

tank's future. Second, plans to employ the 25mm BUSHMASTER cannon on the XM1 were in doubt due to delays in the cannon's development. Third, the US had agreed to a shoot-off among the US 105mm main gun, the FRG 120mm main gun, and the British 110mm main gun, with the winner being selected for the XM1.³⁵

The CSA tasked the Commanding General (CG), TRADOC to conduct a review of the user's requirements to ensure there was still complete agreement.³⁶ The Tank Special Study Group (TSSG) was formed to conduct the review.³⁷ A final report was issued on 30 June 1975.

"Specifically, the TSSG was to revalidate the original requirements for the XM1, not with the preconceived notion of changing them, but to provide compelling arguments and data to support recommended revisions which would be incorporated into the follow-on production contract for the XM1."³⁸

Figure 4-8³⁹ shows the study tasks.

³⁵ Neither the implications of the Yom Kippur War nor the problems with the BUSHMASTER are central to this report. The Tripartite main gun evaluation will emerge as an issue in the FSED decision.

³⁶ HQ TRADOC, "Letter of Instruction for Tank Special Study Group." 14 August 1974.

³⁷ Tank Special Study Group, User Review and Analysis of XM1 Tank Requirements Documentation (U) (Short title: TSSG Study). USAARMC, Fort Knox, KY: 30 June 1975. (SECRET RESTRICTED DATA)
Volume I: (S) Executive Summary (U)
Volume II: (SRD) Revised Materiel Need (Engineering Development) (U)
Volume III: (SNFD) Requirements Review (U)
Volume IV: (S) Effectiveness and Cost Analysis (U)
Volume V: (C) Administrative Appendixes (U)
Volume VI: (S) Threat and US Doctrine (U)
Volume VII: (S) Methodology/Model and Data (U)
Volume VIII: (S) Materiel Summary (U)
(C) After Action Report (U)

³⁸ Ibid., After Action Report, p. 2.

³⁹ Source: Ibid.

- Review the results of the October 1973 Mideast War
- Review the threat profile and expected target array in the long range time frame (1986)
- Review the latest development in tank hardware
- Review, revalidate, or recommend revision of the 1972 MN(ED)
- Consider possible alternatives stemming from the Tripartite main gun "shoot off"
- Revalidate or recommend revisions to complementary armor
- Relate the complementary suppressive fire capability of the XM1 and the Mechanized Infantry Combat Vehicle (MICV) (now the XM2 Infantry Fighting Vehicle (IFV))
- Analyze RAM-D
- Conduct an analysis of performance, effectiveness, and cost

Source: TSSG Study

FIGURE 4-8: TSSG STUDY TASKS

Personnel and training issues were addressed by the study group, but they were not of primary importance. In fact, the study's Executive Summary contains no references to personnel and training issues at all. RA4-D questions were addressed, but not directly related to personnel.

The TSSG drafted a new set of design requirements and order of priority. Figure 4-9⁴⁰ shows the prioritized set of requirements, which can be compared to the MBTTF list in Figure 4-3 above. Crew survivability had emerged as the number one priority as opposed to firepower. This seems to have been a result of increasing Congressional concern over the vulnerability of tanks to ATGMS.

The analysis of the XM1 logistical concept concentrated on fuel, ammunition, and maintenance. While the report recognized the increased requirements for fuel and ammunition, the analysis concentrated on the hardware requirements. A detailed analysis of the impact of XM1 on the logistics system was not undertaken. Ease of maintenance was stressed with emphasis on built-in test equipment (BITE).⁴¹

The Revised MN(ED) presented an Organizational and Operational (O&O) concept calling for five-tank platoons composed of two- or three-tank teams led by a platoon leader or a platoon sergeant. A preliminary Qualitative and Quantitative Personnel Requirements Information (QQPRI) statement called for no change in either the number or the skill requirements of armor crewmen (MOS 11E). Consideration of maintenance support personnel was limited to the statement "Maintenance support personnel for each tank company will include track vehicle mechanics (TVM) and tank turret mechanics."⁴² A Tentative Basis of Issue Plan (BOIP-T) states "Impact of personnel has not been determined. Tools and test equipment have not been identified."⁴³

⁴⁰ The list developed by the TSSG is CONFIDENTIAL; the figure uses a list published in Ludvigsen, op. cit., p. 34. This unclassified list is sufficiently accurate for this report.

⁴¹ Ibid., (SNFD) Vol. III: Requirements Review (U), Chapter 4.

⁴² Ibid., (SRD) Vol. II: Revised MN(ED) (U), p. 10.

⁴³ Ibid.

1. Crew survivability
2. Surveillance and target acquisition performance
3. First- and subsequent-round hit probability
4. Time to acquire and hit
5. Cross-country mobility
6. Complementary armament integration
7. Equipment survivability
8. Environmental impact
9. Silhouette
10. Acceleration and deceleration
11. Ammunition storage
12. Human factors
13. Productibility
14. Range
15. Speed
16. Diagnostic aids
17. Growth potential
18. Support equipment
19. Transportability

Source: Army Magazine, February 1976

FIGURE 4-9. XM1 DESIGN REQUIREMENTS PRIORITY

The study group was concerned with the ability to predict gunnery performance based on psychomotor tests. Data from the M60A1E3 OT II collected by ARI/Fort Knox was used in an attempt to determine whether or not gunnery performance could be determined from a battery of psychomotor tests.⁴⁴ The TSSG concluded "there was a strong indication that there may be some correlation between certain measures of psychomotor ability and gunner proficiency."⁴⁵

The study group emphasized AMC's requirement to provide TRADOC with sufficient information for personnel and training planning.

"The materiel developer must include the following information for equipment development and training support: a listing of duty positions, by descriptive title, required for operation and support of equipment, and suggested placement within a current, revised, or new officer, warrant officer, or enlisted MOS [Military Occupational Specialty], SQI [Special Qualification Identifier], or ASI [Additional Skill Identifier]; a listing of the individual duties and tasks to be performed in each of the above identified positions (duty and task assignments should state how and why the duties are performed in each of the above identified positions, and a listing of the knowledges, skills, abilities and physical and mental qualifications required for the performance of the proposed or revised MOS. The materiel developer must provide this information for both crew and organizational maintenance personnel and include judgments on task difficulty and criticality to MBT mission

44 USAOTE, M60A1E3 Operational Test II (U), OT-014-TEF, Falls Church, VA: April 1975 (CONFIDENTIAL), pp. 80-107.

45 TSSG., (SNFD) Vol. III: Requirements Review (U), p. 121. (The original M60A1E3 report seems less optimistic, reporting "no statistical significance" and "small sample size;" see USAOTE, M60A1E3 OT II, op. cit., pp. 80-107.)

accomplishment and standards of human performance and instructional methods. The above information is essential for the development of the Qualitative and Quantitative Personnel Requirements Information (QQPRI) and the NETP [New Equipment Training Plan] training package. The above information must be reviewed by both the combat developer and the trainer to ensure completeness."⁴⁶

It is interesting to note that this information requirement was not stated for Direct Support/General Support (DS/GS) personnel.

In reference to the training package, the TSSG stated "Adequacy of the final package will be evaluated during DT/OT II."⁴⁷ For training devices:

"The training devices must be developed concurrently with the XM1. Production models of the Driver Trainer and Conduct of Fire Trainer should be delivered to the user prior to XM1 DT/OT II. This would serve a twofold purpose. First, by having these training devices available prior to the XM1 DT/OT II, the user would be able to familiarize the test crews to the XM1 in a hands-on manner. Secondly, the evaluation of the two training devices can be conducted simultaneously with the XM1's DT/OT II. Also, refresher/concurrent training can be conducted on these devices and enhance the performance of the XM1 testing. The Organizational, Direct Support/General Support and Full Crew devices should be delivered to the user prior to XM1 DT/OT III."⁴⁸

⁴⁶ Ibid., (SRD) Vol. II: Revised MN(ED) (U), p. 35.

⁴⁷ Ibid.

⁴⁸ Ibid., (SNFD) Vol. III: Requirements Review (U), p. 12-5.

4.4.2 Training Device Requirements

The identification of the requirement to have training devices was recognized by the MBTTF, but not in any detail. The original XM1 master schedule called for submission of Training Device Requirements (TDRs) to HQDA by TRADOC on May 1974.⁴⁹ TRADOC, however, moved very slowly in developing these requirements, apparently due to considerable internal disagreement.

On 20 May 1974 USAARMS forwarded Draft Proposed TDRs (DPTDRs) to TRADOC for a tank driver trainer, turret trainer, and a turret repairman maintenance trainer. The DPTDRs were staffed world-wide in June and returned to USAARMS for revision on 13 September. The major objection to the DPTDRs came from Deputy Chief of Staff for Training (DCST), HQ TRADOC, who felt that USAARMS approach represented "old fashioned thinking."⁵⁰ He wanted the XM1 training devices to employ the latest technology in simulation.

DCST was particularly interested in incorporating "on-board training" for the XM1 crew. This concept involved a device which would have the capability of accessing information from the ballistic computer via a plug-jack or other output mechanism to interact with a simulator-inputted computer generated image (CGI) of an object (T-62 tank) portrayed in the proper scale of the tank's fire control optics and the crew vision blocks. The ballistic computer would calculate the amount of lead and superelevation introduced into the gun based upon gunner lead rate in relation to the speed of the image movement, the type of ammunition accessed, and a fake impulse input by the simulator into the laser range finder and ballistic computer. The ballistic computer would uniquely define where the round would "hit" and would provide fire control input to an on-board "black-box" simulator (digital computer) which generates the CGI input, determines where the round would hit in relation to image, and provides realistic obscuration in the tank loader. Thus the tank would have its own integral simulator. That would eliminate the need for a separate simulator and would allow crews to train wherever the tank may be - motor pool, local training area, etc. This differed from the then current family of vehicle-dependent conduct of fire trainers in that it would have provided realistic cues to all crew members.⁵¹

⁴⁹ ODCSRDA, "Master Schedule for XM1 Tank System (U)," Washington, D.C.: 6 September 1978. (CONFIDENTIAL)

⁵⁰ DCST quoted by a contemporary member of the DCST staff in an interview with the study team.

⁵¹ TRADOC/AMC, "Letter of Agreement for XM1 Tank System Training Devices." Fort Monroe, VA: 8 April 1976, Annex A, paragraph 2a (3) (f).

Such a concept would, of course, require a modification to the tank's design. In September 1974 DCST requested the TSSG to consider this approach.⁵² The Chief, TSSG, replied that he was surprised but interested in the idea, however, the TSSG report makes no reference to it. PM XM1 was not favorably disposed to any idea which might increase the production cost of the tank.

The internal disagreements at TRADOC were not limited to XM1. TRADOC was in the process of completely reassessing its approach to training development in general and training devices in particular. Under the dynamic leadership of General William E. DuPuy, CG, TRADOC, new concepts in the training development cycle were being developed which would have considerable impact on the XM1 program. Among these were Cost and Training Effectiveness Analysis (CTEA),⁵³ Integrated Technical Documentation and Training (ITDT), Soldier's Manuals (SMs), and How-to-Fight Manuals.

Meanwhile, PM XM1 was urging TRADOC to come to a decision. On 5 November 1974 PM XM1 requested the TRADOC Training Devices Requirements Office (TRADER)⁵⁴ to provide expeditious action on finalizing the TDRs.⁵⁵ On 20 November 1974 HQ TRADOC notified the PMO that the TDRs would be delayed due to an on-going analysis of training requirements. PM XM1 emphasized his concern in January 1975; he pointed out that he required the DPTDRs by 1 July 1975 if they were to be incorporated on the FSED RFP and that the TDRs would have to be approved by HQDA no later than 15 December 1975 if they were to be incorporated in the FY77 budget.⁵⁶

TRADOC, however, was "thinking big."⁵⁷ DCST was completely reevaluating the whole approach to manning and training tank crews:

⁵² Letter from MG P.F. Gorman, DCST, to COL(P) G. Otis, Chief, TSSG, 20 September 1974.

⁵³ Now known as Skill Performance Aids (SPA).

⁵⁴ Later known as the Training Devices Directorate (TDD), Army Training Support Center (ATSC); now known as the Directorate of Developing Systems and Training Devices (DSTD), ATSC.

⁵⁵ Letter from PM XM1 to Chief, TRADOC TRADER, dated 5 November 1974.

⁵⁶ Letter from MG R. J. Baer, PM XM1 to MG P. F. Gorman, DCST, dated 28 January 1975.

⁵⁷ DCST quoted by a contemporary member of the DCST staff in an interview by the study team.

"Basically, we can take three approaches to training crews for the XM-1, which I will discuss in terms of three models, for alternative approaches, as follows:

"a. Process. We train crews for the XM-1 as we have trained them in the past for other tanks. We would have a training base which looks very much like that of today, with a combined BCT/AIT [Basic Combat Training/Advanced Individual Training] turning out individual replacements who would then proceed to units for filling out crews. Leaders for the crew (gunner, commander) would be trained within the NCOES [Non-Commissioned Officer Education System], and would rise to their position through the ranks, accumulating the experience over time.

"b. Bomber Command. Recognizing that the XM-1 is a very expensive system, with an extraordinarily capable weapon whose reach extends that of any present weapon, and hence will invalidate our present range complexes, we would plan to train all XM-1 crews at the same installation. We would set up at a place where we had plenty of room (e.g., Fort Bliss or Fort Irwin), a range complex wherein we could do full justice to the weapon system. Thither we would fly XM-1 crews perhaps as often as three times per annum, from wherever they were located in the world, for service practice. This training center would contain everything that we could devise by way of effective approaches to developing the man-weapon interface. (We have done this with the NIKE HERCULES system, and others in the past.) Individual replacements and NCO's would come out of the normal tank training stream, be formed into crews in their units, and promptly sent off to the "bomber command" for turning into an effective, qualified crew.

"c. Warrant Officer Ace. In this approach we would abandon our traditional notion of

manning tanks and go out for high capability in the tank commander and gunner. As we offer Warrants to individuals who can meet the physical and mental characteristics required of aircraft pilots, we would offer Warrants to young men willing to enlist as a tank commander or gunner. These we would train in an institutional setting to man the XM-1, and to train a crew. They would then proceed to the unit, pick up their equipment, and train a driver and loader which would come to them out of the usual replacement stream. They would be assisted by simulators and other equipment designed to maximize their capability to gain and maintain proficiency within the crew in the unit environment.

"Our approach to the TDR ought to consider each of these (and possibly others) and conceivably some combination of b and c. We should be clear, however, that these decisions should be faced early, rather than late, since they have impacted heavily on the procurement and support cost of the system."⁵⁸

The "Bomber Command" and "Warrant Officer Ace" ideas did not surface again in the program.

TRADOC then decided that a TRADOC/AMC Joint Working Group (JWG) should be established to develop the XM1 Training Devices Letter of Agreement (LOA). An LOA would provide the mechanism to begin funding of a development effort by the PM, Training Devices (TRADE). Established on 28 March 1975,⁵⁹ the JWG submitted a first draft LOA for staffing on 7 May 1975.⁶⁰

⁵⁸ Memo. ATTNG-30-1(1) from MG P.F. Gorman, 30 January 1975.
Subject: Tank Crew Training and the XM-1.

⁵⁹ Letter from TRADOC TRADER, ATTNG-TD, dated 28 March 1975.
Subject: Requirements Documentation for Simulative/Communicative Training Devices to Support the XM-1 Weapon System.

⁶⁰ Letter from USAARMS, ATSB-DT-TP, dated 7 May 1975. Subject:
Letter of Agreement to Develop Training Devices to Support the XM-1 Weapons Systems.

The first draft LOA asserted "The primary emphasis of device development will be on relatively simple, easy to operate, easy to maintain devices for use at the unit level."⁶¹ The XM1 training package was to support crew, organizational maintenance, and DS/GS maintenance training. The concept called for a family of devices divided into seven functional areas. Figure 4-10⁶² shows the functional areas and estimated unit production costs.

The first draft LOA calls for the driver trainer, the COFT, and FCIS to support unit level training as well as special training base and institutional requirements. The maintenance trainers are intended for institutional training, but could hopefully be adaptable for unit training.

PMO XM1 responded to the first draft LOA on 4 August. As a result the JWG met again on 3 September to revise the draft. A new version was staffed on 17 September.⁶³ This draft LOA contained a considerable number of changes in both technical requirements and cost. Only three devices were now contemplated, along with an ITDT package. All maintenance trainers were omitted. Figure 4-11⁶⁴ shows the proposed training devices and the unit production costs.

The draft LOA dropped the requirement that the driver trainer be used at unit level; it was to support institutional training only (or perhaps special training bases). The FCIS was to be distributed at the tank battalion/armor cavalry regiment level. The ITDT was to be multi-media, but simple in design, for on-the-job use; the use of simple devices was not excluded. The concept of "on-board training" was included as an alternative to be considered. On 22 September 1975 the Commandant, USAARMS, was briefed on the LOA as well as the issues of maintenance trainers vs. ITDT and simulation vs. operational equipment. He had reservations about ITDT, "since at the present time

⁶¹ XM1 JWG, "Draft Letter of Agreement to Develop Training Devices to Support the XM1 Weapons Systems," 7 May 1975.

⁶² Source: Ibid.

⁶³ F. Coombs, "XM1 Training Device Chronology." Ft. Monroe, VA, 1 October 1975.

⁶⁴ XM1 JWG, "Draft Letter of Agreement for XM1 Tank System Training Devices," 17 September 1975.

<u>TRAINING DEVICE</u>	<u>UNIT COST FOR PRODUCTION*</u>
1. Driver Trainer	800
2. Conduct of Fire Trainer (COFT)	40
3. Full Crew Interaction Simulator (FCIS)	1900
4. Organizational Tracked Vehicle Mechanic Training Device	300
5. Organizational Turret Mechanic Training Device	300
6. DS/GS Tracked Vehicle Mechanic Training Device	700
7. DS/GS Turret Mechanic Training Device	700

*In thousands of FY75 dollars, excludes development costs

FIGURE 4-10. FIRST DRAFT XM1 LOA TRAINING DEVICES AND
UNIT PRODUCTION COSTS (7 MAY 1975)

<u>TRAINING DEVICE</u>	<u>UNIT COST FOR PRODUCTION*</u>
1. Driver Trainer	1620
2. Conduct of Fire Trainer (COFT)	40
3. Full Crew Interaction Simulator (FCIS)	1000
4. Organizational and DS/GS ITDT Package	.073

*In thousands of FY75 dollars, excludes development costs

FIGURE 4-11. DRAFT XM1 LOA TRAINING DEVICES AND UNIT
PRODUCTION COSTS (17 SEPTEMBER 1975)

it is all talk,"⁶⁵ and indicated that USAARMS should not take a firm stand on maintenance trainers until ITDT was validated. The USAARMS staff had reservations about simulators and the Commandant indicated that he wanted to see a demonstrated capability before procurement. The commandant endorsed the COFT and a simplified driver trainer, but he was opposed to any sophisticated driver trainer and the FCIS.

On 15 October 1975 PM TRADE concurred on the LOA with reservations. He questioned the desirability of a development effort for an institutional driver trainer and the technical feasibility of the FCIS; he did not agree with the restriction that the unit cost of the FCIS should not exceed the unit cost of the XM1 tank. The "on-board training" approach was to be investigated as an approach to the FCIS. The absence of maintenance trainers was noted and the possibility of off-the-shelf procurement of driver trainers considered.⁶⁶

The draft LOA was staffed and approved. It was published on 8 April 1976, signed by DCST for TRADOC and the Director of Development and Engineering for DARCOM.

TDRs still were required. By this time TRADOC had lost the opportunity to incorporate them into the FSED RFP or the FY77 budget. Three studies were commissioned to analyze training devices:

- Sperry Secor was asked to look at training device feasibility by PM TRADE
- Unified Industries, Incorporated (UII) examined uses of the COFT for PM TRADE
- BDM Services Company (BDMSC) conducted a Cost and Training Effectiveness Analysis (CTEA) on crew trainers for ATSC.

The Sperry contract was to examine the feasibility of training devices for application to armor systems. Unfortunately, the

⁶⁵ Memorandum for Record from USAARMS, ATSB-DT-TP-UT, 24 September 1975. Subject: Commandant Briefing, 22 September 1975, LOA on XM1 Training Devices.

⁶⁶ Msg 151930Z from PM TRADE, AMCPM-TND to PM XM1, AMCPM-GCM, 15 October 1975, Subject: XM1 LOA Training Devices.

study was cancelled before completion, when Sperry refused to agree to disqualify itself from any future procurements for XM1 training devices; as a result nothing came of the study.

The UII study surveyed the market for potential COFT suppliers and acquisition costs. Five suppliers were identified.⁶⁷

The CTEA was begun in January 1976. Due to contracting and technical delays, BDMSC did not finish until February 1977.⁶⁸ Only the COFT was examined in detail. BDMSC conducted what it termed a "more macro analysis"⁶⁹ of the driver trainer and FCIS due to lack of sufficient information; no other devices were considered.

A comparison of the relative training effectiveness of the candidate COFT was made using the TRAINVICE model developed for ARI by the American Institutes for Research.⁷⁰ The approach had previously been applied to two non-major system CTEAs.⁷¹ The TRAINVICE approach allows the analyst to examine the extent to which a particular device covers the required skills and knowledges and allows him to compare how well learning guidelines are implemented in one device relative to another. It is a useful tool for choosing between two devices, but it does not establish the effectiveness of a device nor estimate the amount of training required. In spite of its many shortcomings, TRAINVICE was (and essentially still is) as good an approach as is available for assessing devices in the conceptual stage.

The CTEA concluded that a COFT was justified and that the driver trainer and the FCIS be further defined. It also recommended that a prototype FCIS be procured for experimental purposes.

⁶⁷ Unified Industries, Inc., Conduct-of-Fire Trainers Study, Alexandria, Virginia: 18 June 1976.

⁶⁸ William Elliot, et. al., Cost and Training Effectiveness Analysis for XM1 Tank Training Devices, BDM/CARAF-TR-76-037. BDMSC, Fort Leavenworth, KS: February 1977. (two volumes)

⁶⁹ Ibid., p. I-3.

⁷⁰ George Wheaton, et. al., Evaluation of the Effectiveness of Training Devices: Literature Review and Preliminary Model. USARI, Alexandria, Virginia: March 1974.

⁷¹ John J. Kane, et. al., Panoramic Moving Target Screen (PMTS) Cost and Operational/Training Effectiveness Analysis (COEA), BDM/CARAF-TR-76-064. BDMSC, Fort Leavenworth, KS: September 1976; and John J. Kane, et. al., Remoted Target System (RETS)--Non-System Training Device cost and Operational/Training Effectiveness Analysis (COEA), BDM/CARAF-TR-76-065. BDMSC, Fort Leavenworth, KS: September 1976.

The US Army Ordnance and Chemical Center and School (USAOCCS)⁷² investigated the use of maintenance trainers. A June 1976 study of Educational Computer Corporation's ECII simulator was used to justify the usefulness of troubleshooting trainers.

The Demonstration and Validation Phase officially ended in July 1976 when ASARC II met. At that time the development work in training devices under the LOA of April 1976 had just begun. The TDRs, due May 1974, had still not reached the final draft stage. Only the COFT had been studied in any depth.

USAARMS continued its efforts to define TDRs. The Directorate of Training Developments (DTD) conceived of the idea for a loader trainer. Two COFTs, one for unit training and one for institutional training (one-station unit training (OSUT)), were considered. Maintenance training was still to be implemented through ITDT.

The concept of a FCIS was transforming into a FCIS Laboratory (FCIS-L), an experimental facility to investigate armor human factor, personnel, and training questions. The US Army Research Institute for the Behavioral and Social Sciences (ARI) at Fort Knox was to be the primary user. The FCIS-L was slowly dissassociated from the XM1 program. PM TRADE eventually awarded a contract to build the FCIS-L, but it was later cancelled due to rising costs.

USAARMS convened an XM1 TDR Conference on 22-23 November 1976. USAARMS asserted its requirement for:

- Driver trainers
- Loader trainers
- COFT-UNIT
- COFT-OSUT
- FCIS-L

Maintenance training was still projected by ITDT. PM TRADE expressed reservations about trying to field training devices prior to OT II;

72 Now the US Army Ordnance Center and School (USAOCS).

USAARMS and USAOC&S agreed that this was not necessary. PM TRADE proposed to have device prototypes for devices' OT II to train personnel at tank OT III. The JWG was scheduled to meet in December to draft TDRs.⁷³

A set of draft TDRs were developed and staffed at TRADOC. In March 1977 PM TRADE provided validated cost estimates. In July 1977 TRADOC submitted them to HQDA, which approved them between September 1977 and January 1978. Figure 4-12⁷⁴ shows the approved TDRs with unit production cost estimates.

4.4.3 Other Planning

Training and personnel planning during the Demonstration and Validation Phase was necessarily limited, since the number of Army personnel with access to the contractors plans was extremely small. To a large extent, planning had to be based on the MN(ED).

In addition to the items already discussed, TRADOC was preparing an Individual and Collective Training Plan (ICTP) as a major planning document. The ICTP was prepared in parallel with the TDRs and had similar difficulties. An original due date of March 1976 was missed, but a draft was issued in June 1976. A number of difficulties, closely related to concurrent ones with TDRs, delayed a submission to HQDA until June 1977. HQDA approved the ICTP in September 1977. By this time, of course, the tank was well into FSED.

At the request of TRADOC, the Army Concepts Analysis Agency (CAA) conducted a Cost and Operational Effectiveness Analysis (COEA). The alternative systems examined were the XM1, the M60A3, and the M60A1AOS; the last served as the base case. The study does not appear to have taken any particular interest in personnel or training issues. Human capabilities are essential components of the simulations employed, but the COEA⁷⁵ seems to have based such capabilities on hardware capabilities.

⁷³ USAARMS, ATSB-TD-CDP, Memorandum, 24 November 1976. Subject: XM1 Training Device Requirements Conference, 22-23 November 1976.

⁷⁴ Source: USARMC, TRADOC Individual-Collective Training Plan (ICTP) for the XM1 Tank System. Fort Knox, KY: January 1980, Appendix C.

⁷⁵ USACAA, XM1 Systems/Force Mix Cost and Operational Effectiveness Analysis (XM-1 S/FMCOEA) (U). Bethesda, MD: February 1976 (SECRET) (3 volumes).

<u>TRAINING DEVICE</u>	<u>UNIT COST FOR PRODUCTION*</u>
1. OSUT-COFT	610
2. UNIT-COFT	125
3. Driver Trainer	130
4. Transmission Troubleshooting Trainer	33
5. Hull Electrical Systems Troubleshooting Trainer	33
6. Engine Troubleshooting Trainer	33
7. Laser Rangefinder Troubleshooting Trainer	33
8. Ballistic Computer Troubleshooting Trainer	33
9. Tank Thermal Sight Troubleshooting Trainer	33
10. Turret Troubleshooting Trainer	33

*In thousands of FY76 dollars

FIGURE 4-12. TRAINING DEVICE REQUIREMENTS WITH
UNIT PRODUCTION COSTS (July 77)

4.5 FSED DECISION

While the decision for the XM1 program to enter FSED does not bear directly on the integration of personnel and training subsystems (except as it represents a milestone successfully passed), the facts, considerations, and actions surrounding the decision are of interest in terms of their reflection of the significant external pressures present in a major system development program. These pressures, which normally take the form of challenges to the program itself, or to the manner in which it is progressing, are significant in that they generate a requirement for the expenditure of significant time and energy on the part of the Project Manager, his staff, and other supervisory and staff personnel at higher levels to respond. Thus, while normal program activities proceed at their own pace, the priority for attention is clearly focused on questions which relate to the overall survival of the program itself.

In the case of the XM1, a major challenge - represented by the issues of NATO standardization and a potential for procurement of the German Leopard 2 in place of a US design - impacted the program for a full year (1976), and specifically the FSED decision which was scheduled for July 1976. The beginnings of this story are found in a Memorandum of Understanding (MOU), negotiated between the US and the FRG in December 1974 which called for collaboration between the two countries in their tank programs with a view toward "harmonization" (the FRG term) of interests and designs. The next step was the gun caliber issue and the resulting "shoot-off" between the US, the United Kingdom (UK), and the FRG in mid-1975. During the same period a senator requested that the General Accounting Office (GAO) conduct a review of the program with the objective of determining the desirability of halting XM1 development until standardization issues could be sorted out. Additionally, in the Spring of 1975 the FRG under existing agreements shipped their Leopard 2 prototype to Canada for cold weather and to the US (Yuma Proving Ground) for desert tests.

With these activities as a backdrop, the contractor FSED proposals were delivered and DT/OT I testing accomplished in the first half of 1976, as described in Subsection 4.3.2 above. With the evaluation of proposals and test results completed, and the FSED decision and selection of a contractor scheduled for July, a major uncertainty was injected into the program at the eleventh hour. Expected to announce the selection of a competition winner on 10 July, the Secretary of the Army instead announced a delay in source selection of 120 days in order to reevaluate US contractor designs

reconfigured to accommodate the FRG 120mm gun.⁷⁶ During the same month an addendum to the previously mentioned US/FRG MOU was negotiated in which the two countries agreed on areas of standardization of their tank systems: "a dual capable turret which would accommodate both 105mm or 120mm gun systems; a turbine power package capable of using standard fuel; track and associated hardware; US night vision devices, FRG gunner's auxiliary telescope, and standard metric fasteners at unit level maintenance interfaces."⁷⁷ Thus, not only was the schedule impacted by a four month delay, but the entire design of the turret, fire control system, and main gun associated hardware called into question.

Associated with the addendum to the MOU, an agreement was also reached by which the Leopard 2, reconfigured in some aspects to meet US requirements, was brought into the competition.⁷⁸ This caused a number of objections to be raised in the Congress, centering directly on the Secretary of Defense, who was presumed to be contravening Congressional desires by delaying the program in the interests of standardization.⁷⁹

Without further belaboring these challenges to the program, it can be noted that the contractor FSED proposals were revised, a winner - Chrysler Corporation - selected in November 1976, and the FSED phase entered upon. The Leopard 2 was evaluated outside the US

⁷⁶ "XM-1: NATO Standardization Breakthrough, or Rumsfeld's TFX?," Armed Forces Journal, September 1976.

⁷⁷ "XM1 Tank System," pamphlet published by the PMO, undated (Feb 1976). Use of the dual capable turret was not part of the MOU (only the eventual use of the 120mm gun) but rather a DA requirement on the competing contractors, according to COL F.L. Day, TSM XM1, memorandum for Dr. Haggard, Chief, ARI Field Unit/Fort Knox, dated 9 September 1980. Subject: Draft SAI Report 81-233-WA; Personnel and Training Subsystem Integration in an Armor System.

⁷⁸ "The Tank Dilemma," The Wall Street Journal, 12 August 1976.

⁷⁹ "House Panel Slams XM-1 Delay," Armed Forces Journal, October 1976.

competition and eliminated from consideration. Remaining was the determination of which gun would be incorporated into the tank, an issue not resolved until February 1978 with a decision to equip the first 1000-1500 tanks with the US 105mm and subsequent production with the German 120mm, noting that it would not be ready until 1984.⁸⁰ At the time the Washington Post stated:

"In behind-the-scenes maneuvering, it was reported that the decision on the gun question would determine whether the West Germans would help finance a costly new airborne warning and control airplane fleet for NATO."⁸¹

In summary, the preceding recounting of the facts and circumstances - and customs - surrounding the FSED decision brings out two major points: First and in general terms, management personnel associated with major system development programs are subjected to significant pressures which impact their view of priorities. Second, in terms of the XM1 itself, reconfiguration of the turret and weapon system changes could certainly be expected to impact the progress of ILS development.

4.6 FSED: CONTRACT AWARD AND TEST

4.6.1 Source Selection

Preparation for FSED was well underway before DT/OT I. The SSEB was reconvened to establish the provisions of the FSED RFP. Several decisions critical to the personnel and training subsystems were made.

The contractor was required to prepare a Task and Skill Analysis (TASA) Report, which was to serve as the Front-End Analysis (FEA) for training development. The data item description (DID) chosen was DI-H-6130(MOD), developed by the Navy in 1971; it is the oldest of the four task analysis DIDs still authorized for use in DoD contracts. The DID does not define the levels of human behavior in operations and maintenance to be reported, nor does it require inclusion of the times required for the performance of each task.

⁸⁰ "Army Chooses a German Made Gun Over U.S. Model for the XM1 Tank," Washington Post, 1 February 1978. Current production plans call for 3000-4000 tanks with the US 105mm gun, according to Day, TSM XM1, memo for Dr. Haggard, op. cit.

⁸¹ Ibid.

The contractor was responsible for preparing an ITDT package for use at OT II as a prototype of the version to accompany deployment. It was recognized that in order to validate the package the contractor would require a tank. Since the eleven vehicles to be procured were already fully scheduled, a twelfth tank would have to be purchased to accomplish validation. Rather than incur this additional cost, the contractor was excused from validation requirements.⁸² No action was taken to assign this task to a government entity.

An integral part of the FSED procurement is the Logistic Support Analysis (LSA) and Logistic Support Analysis Record (LSAR), governed by AR 700-127, Integrated Logistic Support; MIL-STD-1388-1, Logistic Support Analysis; and MIL-STD-1388-2, Logistic Support Analysis Data Element Definitions. LSA is an analytical technique used to provide a continuous dialogue between designers and logisticians, providing a system to identify, define, analyze, quantify, and process logistic support requirements for materiel acquisition programs. LSAR is the data system that supports LSA.

In order to cut costs, a full LSA/LSAR was not required of the contractor.⁸³ As a result the requirements of AR 700-127 were not completely met.

The competitors, GMC and Chrysler, submitted FSED program plans in May 1975 and proposals in February 1976. While the program was delayed due to the Leopard 2 tests, GMC and Chrysler were given the opportunity to amend their proposals. On 16 November 1976 the Secretary of the Army awarded the contract to Chrysler Corporation.

As part of its design effort, Chrysler established a human factors engineering (HFE) program⁸⁴ in accordance with DI-H1312A, HFE Program Plan. An XM1 HFE/System Safety (HFE/SS) Group was established

⁸² Based on an interview by the study team with a former member of the SSEB.

⁸³ Msg 281638Z from TSM XM1, ATZK-XM1 to PM XM1, 28 November 78. Subject: XM1 Logistic Support Analysis Record (LSAR).

⁸⁴ Chrysler Corporation, XM1 Tank Program HFE Plan for FSED/PEP, Revision B. Sterling Defense Division: Sterling Heights, MI: 1 October 1976.

to assure adequate consideration of human factors issues. The Human Factors Engineering and Safety Design Guide⁸⁵ was published to provide design personnel with a summary of all the HFE/SS related system design requirements and a convenient source of some of the most frequently used HFE and safety design criteria.

As part of its HFE Program Plan, Chrysler was to provide task times, even though not required by DI-H-6130.⁸⁶ Chrysler also promised the identification of critical tasks.

4.6.2 Preparation for Testing

Preparation for DT/OT II also began early. TRADOC supplied its input to the DT II and OT II Outline Test Plans (OTPs) in October 1975. The plans were published in April 1976 by the Army Materiel Systems Analysis Activity (AMSAA) and OTEA respectively.

Coordination for testing was through the XM1 FSED Test Integration Working Group (TIWG). The TIWG contained representatives from all the major interest parties, including HQDA, HQ DARCOM, HQ TRADOC, PMO XM1, USAARMC, USAOCCS, LOGC, TECOM, AMSAA, OTEA, MRSA, and LEA. As a regularly meeting forum, it served as a clearing-house for many of the program interface problems.

About a month after the FSED contract award, the first TIWG meeting was held. It was the consensus of the TIWG that some provision for formal review of training manuals was needed, but what group was appropriate was not decided.

At a TIWG meeting in February 1977 the slow progress of TDRs was discussed. The minutes note: "There is concern within the test community that training device developments are not keeping pace with

⁸⁵ Chrysler Corporation, Human Factors Engineering and Safety Design Guide. Sterling Defense Division: Sterling Heights, MI: 15 January 1978.

⁸⁶ HEL/MRDC, Human Factors Engineering Analysis (HFEA) for XM1 Tank System ASARC III. Aberdeen Proving Ground, MD: 10 January 1979.

⁸⁷ PMO XM1, "Minutes of the 1st TIWG, 15-16 December 1976." 4 January 1977.

XM1 system developments. It is desirable that the development of all training devices parallel the development of the XM1 and be available during the test cycle."⁸⁸

At the meeting TRADOC representatives pointed out that AR 1000-2 requires that technical and training publications, Training Extension Courses (TEC), and prototype training devices be evaluated during OT II. PMO XM1 representatives replied that these requirements are in conflict with the FSED contract, but that they would try to develop a response with "recommendations as to how it can meet the spirit of the regulations."⁸⁹

In March 1977 PMO XM1 clarified its position. TRADOC's requirement for job performance measures and guides (JPM/JPG) for OT II training would be met; but the requirement for extension training materials (ETM) for OT II would not. Neither would ETM be supported by ASARC III, but would be available for OT III. "The only course of action which will allow XM1 to enter OT II with a total ITDT package is to delay OT II."⁹⁰

USAOCCS was particularly concerned with the ITDT package. They complained about the PMO's administration of the contract effort.

"...any review we might make would be a surface effort at best...The ETM contract is being worked on separately from the manuals. Without an adequate front-end analysis (FEA) and integration of manuals and ETM there is little likelihood of an effective training product....It would appear that the XM-1 ITDT effort may be in name only."⁹¹

⁸⁸ PMO XM1, "Minutes of the 2nd TIWG, 9-10 February 1977." 2 March 1977.

⁸⁹ Ibid.

⁹⁰ Memorandum for Record from PMO XM1, DRCPM-GCM-L, 14 March 1977. Subject: ITDT.

⁹¹ Mag 061012Z from USAOCCS, ATSL-TS to TRADOC, ATTNG-TMI, 6 April 1977. Subject: XM-1 ITDT.

At an April TIWG the PMO initiated a request for a waiver of ITDT requirements. TRADOC agreed to staff⁹² the waiver. A committee to review training questions was established.

The meeting also opened discussions on the vehicle to serve as the baseline for testing. Theoretically the baseline was the M60A3, which PM M60 was prepared to provide for OT II, but not for DT II. However, in a position presented at the TIWG, USAARMS "rigidly opposed" the use of the M60A3 and insisted on the M60A1AOS. USAARMS claimed that the M60A3 would greatly increase its test training requirements and "result in the same problems encountered in past M60A3 tests; that is, is the problem training oriented or system oriented?"⁹³ No decision was reached at that time.⁹⁴

Meanwhile, the PMO was becoming increasingly impatient with TRADOC's inability to finalize its ITDT requirements. Prior to contract award, Chrysler had been given Draft MIL-M-632XX as guidance for ITDT. However, the TRADOC Training Management Institute (TMI) was in the process of revising the specifications with a March 1977 completion due date.⁹⁵ But the concept was not finalized in the spring. PM XM1 was opposed to any action which would cause his schedule to slip.

"We are committed to the ITDT concept and work by Chrysler and several subcontractors is well underway. Existing draft specifications have been provided to the contractor and we are approaching the point where any significant change in guidance or concept from TRADOC would adversely affect our schedule and cost....We will have draft ITDT publications for use in DT/OT II."⁹⁶

⁹² PMO XM1, "Minutes of the 3rd TIWG, 7-8 April 1977." 11 April 1977.

⁹³ USAARMS, "Position Paper," enclosed in ibid.

⁹⁴ 3rd TIWG, op. cit.

⁹⁵ XM1 TDR conference, op. cit.

⁹⁶ Enclosure to Letter from MG R. J. Baer, PM XM1, to LTG E. J. D'Ambrosio, DCG DARCOM, 23 May 1977.

Representatives from the PMO and DTD, USAARMS worked out an agreement to define contractor requirements for OT II training. A Letter of Agreement was promulgated on 23 June 1977.

In August 1977 the TIWG addressed the problem of the baseline tank for OT II. The TRADOC/OTEA position was that the M60A3 would be the baseline, if it were available; if it were not available, the M60A1AOS would be used.⁹⁷ The topic did not again come up at future TIWGs, but at OT II the baseline was in fact the M60A1AOS.

A major IPR on the contractor ITDT package was held on 18-23 September 1977. Chrysler came under severe criticism for its management and quality control of the technical manuals and training materials. The effort was characterized by the dispersion of responsibilities through subcontracts. Manuals for the areas of responsibility of the prime contractor, the Chrysler Sterling Defense Division, were prepared by the Westinghouse Electric Corporation, Electronic Systems Support Division; this accounted for ten vehicle manuals and one test set manual. AVCO-Lycoming, who was producing the turbine engine, was providing two component manuals and two test set manuals. GMC, Detroit Diesel Allison Division, who was manufacturing the final drive train, produced two component manuals. Hughes Aircraft Company, Tactical Systems Division, who developed the ITS, prepared two component manuals and one test set manual. Chrysler Corporation, Huntsville Electronics Division, who designed additional test sets, wrote three test set manuals.

Chrysler had the responsibility of managing the entire ITDT package. This included ensuring that the technical documentation was integrated, up-to-date, and accurate. At the IPR and since, Chrysler has been continually criticized for failure to keep manuals complete and up-to-date and for inadequate quality control, in spite of constant pressure from the PMO to improve.⁹⁸

On 30 September 1977 Chrysler delivered the TASA.⁹⁹ It is unquestionably the most controversial document reviewed in this study.

⁹⁷ PMO XM1, "Minutes of the 5th TIWG, 29-30 August 1977." 3 October 1977.

⁹⁸ Based on interviews by the study team with staff members at TECOM, USAARMC, and USAOC&S.

⁹⁹ Chrysler Corporation, XM1 Tank Program FSED/PEP Phase Task and Skill Analysis Report (Preliminary) for the XM1 Tank, Combat, Full Tracked 105mm Gun. Report X-COON 1. Sterling Defense Division: Sterling Heights, MI. 30 September 1977. (11 Volumes)

Comments on the TASA ranged from "clearly in accordance with best technical standards" to "worthless."

The purpose of the TASA was to serve as the FEA, the basis for personnel requirements and training design. The primary users were to be USAARMC and USAOC&S for training course development and PM TRADE for training device design.

In general, PMO XM1 and TACOM approved of the Chrysler TASA. Their attitude is in agreement with the assessment of Army Human Engineering Laboratory (HEL):

"Despite the conceptual difficulties facing the contractor as a result of the ambiguities of the government requirement, the report produced shows careful and thoughtful attention to the spirit of the endeavor.

"The contractor provided his own comprehensible scheme for describing the human performance required for operations and maintenance....This information is clearly formatted in 12 volumes...

"The level of detail and structure of the TASA render it suitable as a basis for evaluation and justification of personnel skills within the specified armor crewman MOS designations (MOS 19 series) and for the development of technical documentation (operations and maintenance manuals and other training material)....its scope and style are clearly in accordance with the best professional standards..."¹⁰⁰

Users of the TASA at USAARMC, USAOC&S, and PM TRADE interviewed by the study team were uniformly critical of the work. It was generally described as inaccurate and incomplete with much of it

¹⁰⁰ HEL/MRDC, op. cit.

obsolete. USAARMC was particularly critical of the format, which failed to conform to the job task data card approach favored at Fort Knox.

While it is not within the scope of this study to evaluate the TASA, three particular problems are apparent and are identified in the HFEA.¹⁰¹ First, it is unverified. This is a direct result of the SSEB decision not to require contractor verification. Second, times required for task performance are not given. The DID does not require the contractor to do this, but Chrysler's HFE Plan implies they would. Third, the TASA format does not permit the identification of critical tasks, as promised by the contractor's HFE Plan.

The Training Analysis Division (TAD), USAARMC was requested to review the TASA by the PMO in October 1977. TAD then proceeded to develop their own task lists for MOSs 11E, 45N, and 63C and to prepare the OT II Training Concept Plan (TCP). TAD also tried to encourage USAOCCS to initiate analyses for MOS 63C, but was unsuccessful.¹⁰²

In February and April 1978 PMO XM1 held a Physical Teardown/Maintenance Evaluation (PT/ME) which was intended to provide essential data for estimating Annual Maintenance Man-hours (AMMHs). The PT/ME indicated that there were severe problems with the test sets. Since many of the maintenance functions were dependent upon the test sets, sufficient data was not collected.

4.6.3 DT/OT II

The initial schedule for XM1 DT/OT II called for separate but concurrent testing. About fourteen months were scheduled for DT and eleven for OT with ASARC/DSARC III occurring somewhat past the half-way point in testing. After the program delay due to DSARC II, the schedule was revised. Both tests were delayed about three months, but DT was extended to sixteen months and OT shortened to six. ASARC/DSARC were to occur after OT, but before the end of DT. In actual fact, DT was delayed by about one month; OT began on time, but took eight months. ASARC/DSARC took place before the completion of

¹⁰¹ Ibid., pp. 7-9.

¹⁰² USAARMS, "Job Task Analysis Plan XM1," November 1978, pp. 59-60.

DT. Figure 4-13¹⁰³ shows the schedule changes. The essential fact is that from the project's inception the Production Decision was to take place before the completion of FSED testing.

New Equipment Training (NET) for DT II personnel was held at Aberdeen Proving Ground (APG), Maryland between 17 November 1977 and 12 July 1978. Contractor personnel trained military and civilian government personnel in the operation and maintenance of the XM1. Chrysler provided a draft ITDT package to support the training and the test.

"Since the beginning of DT II, the original technical manuals have been updated on three occasions. The manuals improved with each update; however, they remain deficient because complete sections are still missing from the maintenance manuals, and many procedures are incorrect. In addition, the parts manuals contain only approximately fifty to sixty percent of the total parts..."¹⁰⁴

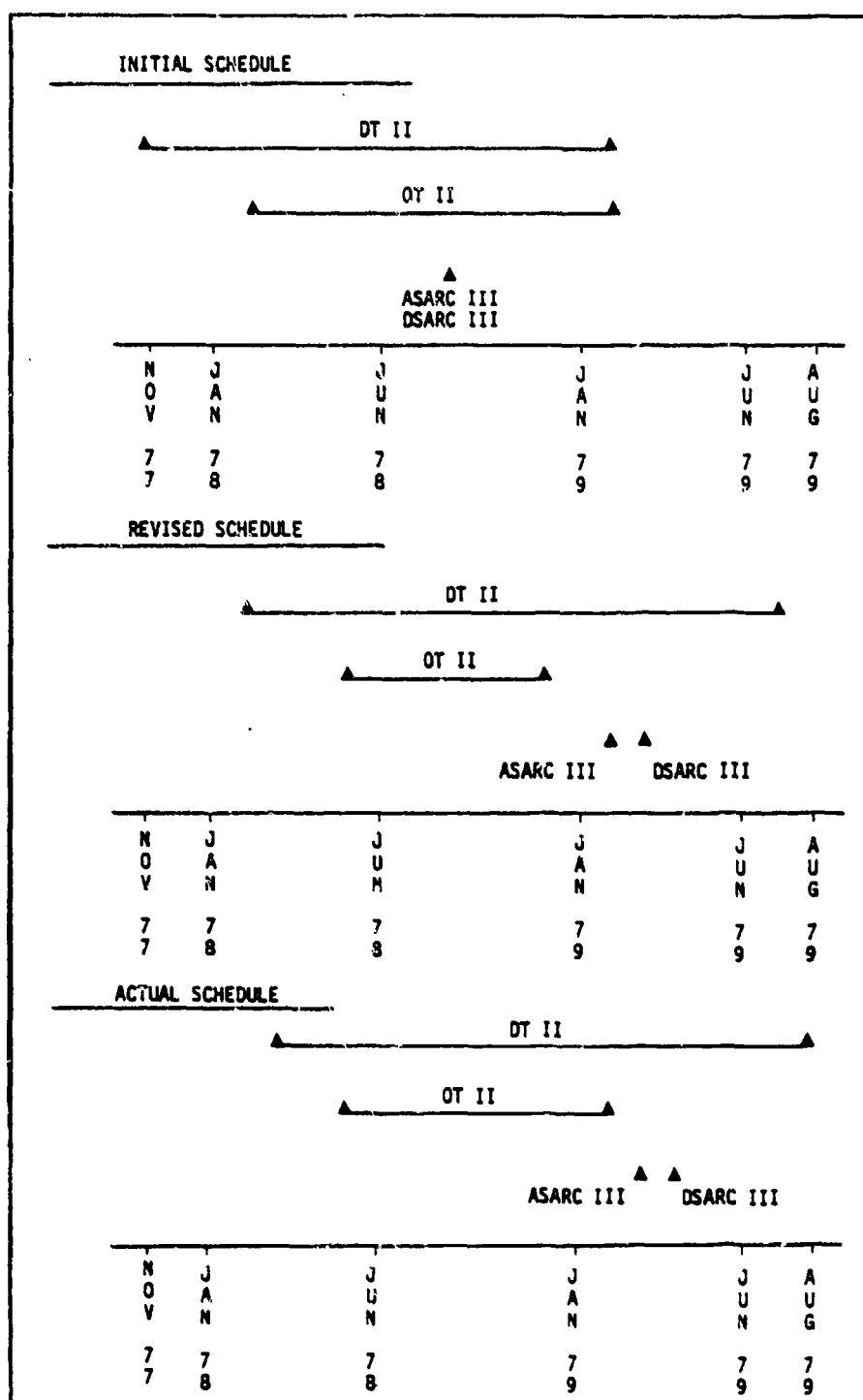
DT II testing began on 15 March 1978. The test results through 21 January 1979 were used to support ASARC/DSARC III and were documented in a partial report in February 1979.¹⁰⁵ DT concentrated on the engineering aspects of the tank and most of its findings are outside the areas of interest to this study. However, some of the findings do bear upon personnel issues.

"The XM1 failed to meet the sustained operational requirement of the revised MN, and fuel consumption was substantially greater than the M60A1 RISE tank..."

- ¹⁰³ Sources: (1) XM1 Master Schedule, op. cit.
(2) USATECOM, Partial Report Prototype Qualification Test-Government (PQT-G) of XM1 Tank System (Temperate Climate Phase) (U), APG-MT-5213. Aberdeen Proving Ground, MD: February 1979. (CONFIDENTIAL)
(3) USAOTEA, Independent Evaluation of the XM1 Main Battle Tank Operational Test II (U), (DT II IER), IEER-OT-049. Falls Church, VA: April 1979. (CONFIDENTIAL)

¹⁰⁴ PQT-G, op. cit., p. 4.

¹⁰⁵ Ibid., passim.



SOURCES: (1) XMI MASTER SCHEDULE
(2) DT II TEST REPORT
(3) OT II IER

FIGURE 4-13. DT/OT II SCHEDULE CHANGES

"The test sets and the XM1 tanks were not compatible. The fire extinguisher and organizational test sets were considered adequate. The TIS (Thermal Imaging System) test set performed with marginal adequacy; this test set is still in the hot mock-up development stage. The remaining four test sets were unreliable, incompatible with the XM1 tank in many areas, and presented erroneous fault diagnoses.¹⁰⁶ These test sets were considered deficient."

Most significantly,

"....the skills, experience, and aptitudes provided by current and/or projected TOE and MOS structure are not adequate for operation and maintenance of the XM1 tanks. Currently, MOS 45N, tank turret mechanic, and 63C, tracked vehicle mechanic, are applicable to the military individuals performing maintenance. These MOS qualified personnel are suitable for some of the military track-laying vehicles such as the APC, M113, but do not have the skills required for maintenance of the sophisticated components of the XM1 tank. This is especially so since the test sets, which have been provided for diagnostic tests of XM1 components, are totally unreliable. Further, the above MOS types could not diagnose troubles in various components, using schematics and standard equipment.

"The proposed program of instruction for training crews and maintenance personnel...has been inadequate to provide the necessary knowledge and skills to operate and support the XM1 tank system. Training, for the most part at APG, has been by contractor personnel for limited times (one to two weeks), with

¹⁰⁶ Ibid., pp. 3-4.

limited access to test sets and equipment. DT II testing at APG to date indicates that highly skilled personnel, both government and contractor, have difficulty in determining the reasons for various vehicle problems. Lesser skilled civilian and military personnel have almost no chance of coping with the intricate vehicle system."¹⁰⁷

In discussions with the study team USOC&S personnel were particularly concerned about the failure of the test sets. Without them the 45N and 63C personnel will be required to employ alternate testing procedures which will require them to know basic electronics not now part of their MOS requirements. USOC&S believes that this could lead to doubling the required training time, provided that these personnel are capable of learning the procedures at all.

TECOM evaluated the Chrysler technical manuals (TMs) using their Instructional Material Analysis Guide and Evaluation System (IMAGES). TECOM in discussions with the study team characterized the TMs as incomplete, ill-written, and subject to change. They indicated that TECOM has since refused to use them.

As in DT/OT I, there was considerable contractor intervention required to keep the tanks operational during DT II.¹⁰⁸ As a result insufficient RAM data was gathered to estimate AMMH.¹⁰⁹

Chrysler prepared a training package for use at OT II. The history of that package was the subject of much inquiry by the study team. According to PMO XM1, the package was reviewed by USAARMC personnel who expressed some criticism of the format. The PMO requested that USAARMC markup the training package as they saw fit and use it at OT II and then return the package to Chrysler at the end of

¹⁰⁷ Ibid., p. 2.17-19. It is interesting to note that these findings do not appear in the report's "Summary of Results" section at all!

¹⁰⁸ Ibid., p. 2.32-4.

¹⁰⁹ Logistics Evaluation Agency (LEA), XM1 Tank ILS Program: Interim Assessment, New Cumberland, PA: 2 January 1979, p. 5.

the test. The package was returned with virtually no changes and became the basis for the SPA package.

USAARMC personnel recall the situation quite differently. The chief of the Mobile Training Team (MTT) reviewed the Chrysler package and found it without merit. He felt that the instructional methods were incorrect and the course was too theoretical. He then decided to assemble his own team of subject matter experts (primarily sergeants and warrant officers) to do their own FEA and completely rewrite the training materials. A crash effort was mounted and a new training package produced and used at OT II. The package was sent to the PMO after the test and became the basis for the SPA package.

The study team has been unable to reconcile these two versions.

OT II was held at Fort Bliss, Texas and divided into three phases. Phase I was training. MTT trained player personnel on the M60A1 and then cross-trained them on the XM1 for crew and organizational maintenance positions. DS/GS players were trained at APG by Chrysler. Opposing forces (OPFOR) players were trained by the Commander, 3rd Armor Cavalry Regiment (ACR). Phase II was the live fire portion of the test. Phase III addressed mobility, survivability, and target acquisition.¹¹⁰

Early in Phase I it became apparent that extraordinary measures would have to be taken to keep the tanks operational. In August 1978

"...end item tank problems in the fire control, hydraulics, and power pack subsystems required major modifications by the contractor. This presented a challenge to the test priorities. End item tank modifications and testing adjustments have not been distributed in program documentation. Impact of current configuration changes on logistical supportability cannot logically be made. However, again (as in DT/OT I) it is reported that maintainability data will be 'soft.'¹¹¹

¹¹⁰ OTEA, OT II IER, op. cit., p. 6. The 3rd ACR conducted the M60A1 according to Day, memo to Dr. Haggard, op. cit.

¹¹¹ LEA, Interim Assessment, op. cit., p. 5.

As in DT/OT I and DT II, Chrysler personnel were performing or advising on maintenance functions that should have been restricted to the player personnel. The Director of Maintenance and Supply, ODCSLOG became sufficiently concerned to contact OTEA.

"1. It has come to my attention that contractor technical assistance provided the XM1 tank during the first phase (training) of OT II has been extensive. It is recognized that technical assistance may be necessary to the conduct of OT II, but in order to preserve the integrity of supply/maintenance data collected, it must be limited, properly executed, and documented.

"2. Our logistics concern is that adequacy of troop supply/maintenance actions, times levels, skills, support equipment, etc., may not be recorded. Therefore, it is recommended that contractor technical assistance be provided the OT II test team only upon request. Also, when such assistance exceeds the test site field level capability, that it be properly recorded as depot level maintenance.

"3. The recommendation is forwarded for the express purpose of resolving and/or avoiding the potential major problem of support data validation through the remaining OT II test program. I'm confident that OTEA shares my concern for valid supportability data and can resolve this problem area, thus assuring valid evaluation of the complete maintenance test support package for the XM1 tank system."¹¹²

¹¹² Letter from MG Alan A. Nord, DALO-SMZ-A, to CG, OTEA, dated 31 August 1978. Subject: XM1 Tank OT II Testing.

In an assessment conducted before the completion of OT II, LEA complained of improper procedures. "An example is that five men may assist on a task prescribed to be accomplished by only one man....Partial¹¹³ logistics test data will provide for only marginal evaluation."

In interviews representatives of both PM XM1 and TSM XM1 have expressed confidence in the procedures employed at OT II. TSM XM1 in particular described some often cited "facts" about improper procedures at OT II as "myths."¹¹⁴

OTEA's analysis concluded that OT II was adequate to evaluate:

- (1) Survivability/Vulnerability
- (2) Target Acquisition and Hitting Performance
- (3) Mobility/Agility
- (4) Reliability and Availability
- (5) Fightability
- (6) Training;

and that "insights" ¹¹⁵ were gained in:

- (1) Maintainability
- (2) Ammunition storage
- (3) Maintenance organization structure
- (4) Class III support requirements.

¹¹³ LEA, Interim Assessment, op. cit., pg. 5.

¹¹⁴ E.g., "the oft cited example where a Chrysler mechanic granted access to a tank for a repair action approved by the Test Directorate preceded to 'fix the tank before it broke.' An XM1 mechanic of this quality simply does not exist." (Day, memorandum for Dr. Haggard, op. cit., pg. 5.

¹¹⁵ "Insights" appears to be a euphemism for inadequate data.

4.7 FSED: PLANNING

4.7.1 The Kalergis Report

In August 1976 CSA established the Tank Forces Management Group (TFMG)¹¹⁶ under retired LTG James Kalergis. TFMG was given a one year charter to develop a program to optimize the combat potential of Army tank forces. The study group's report,¹¹⁷ generally referred to as the Kalergis Report, was not specifically oriented to the XM1, but made some recommendations relevant to the XM1 program.

TFMG criticized tank project managers (PM M60 and PM XM1) for delaying ILS planning.

"Tank PM's are delaying the conduct of detailed ILS planning until their programs enter Full Scale Engineering Development (FSED). While this practice is in conflict with the provisions of the DARCOM Supplement to AR 700-127, it is done to avoid the costs of paying more than one contractor for detailed ILS plans. This strategy makes it impossible to develop complete Logistic and Training Support Packages for OT II. This forces the PM to either extend FSED and conduct an OT IIa or enter a Low Rate Initial Production (LRIP) phase and run an OT III. Either option delays a full production decision, an expensive proposition. Thus, the front end cost savings achieved by delaying ILS planning are lost when the effects of that strategy cause production delays later in the program."¹¹⁸

TFMG noted the fragmentation of responsibilities for the development of tank training devices (TTD).

¹¹⁶ Successor organizations to the TFMG are the Army Force Modernization Office in OCSA and the Office of Armor Force Management (OAFM) at USAARMC.

¹¹⁷ LTG James Kalergis (ret.), et. al., A Program for Maximum Effectiveness...Tank Weapon System Management. TFMG: The Pentagon. Undated (c. August 1977).

¹¹⁸ Ibid., p. V-17.

This fragmentation of TTD program responsibility, coupled with the fact that TRADOC has not provided timely requirements information has led to a breakdown in the capability of DARCOM to field TTD systems.¹¹⁹

A recommendation was made to establish a product manager for TTD. This recommendation was never acted upon.

At the time of the Kalergis Report entry level armor soldiers received MOS 11E. Those soldiers could be assigned to three different crew positions on each of five different vehicles. The TFMG concluded that this required too many skills. They recommended establishing a separate armor career management field (CMF) with system specific and position specific MOSs.¹²⁰ They also recommended systems specific training for maintenance personnel.¹²¹

This led to the establishment of CMF 19 for armor enlisted personnel. Two system specific operator MOSs were created for XM1: 19K, XM1 Armor Crewman and 19L, XM1 Tank Driver. Two organizational maintenance MOSs were established for XM1: 45E, XM1 Turret Mechanic and 63E, XM1 Chassis/Systems Mechanic. At the DS/GS level five MOSs would be awarded the SQI "T."

The creation of XM1-specific MOSs highlighted a personnel management problem. Unless the CONUS/Europe distribution of tank crews was kept fairly even (about 40%/60%) it would be impossible to establish the proper rotation of personnel. While it was desirable to have as many XM1s in Europe as possible, the personnel management system required the concurrent fielding of XM1 to both CONUS and Europe. The XM1 Basis of Issue was adjusted to reflect this requirement.

4.7.2 Personnel Planning

The original XM1 Master Schedule called for submission of the QQPRI by TRADOC to HQDA in September 1977, later revised to August 1978. As of this writing (July 1980) this has not yet been accomplished.

¹¹⁹ Ibid., p. V-19.

¹²⁰ Ibid., p. II-20.

¹²¹ Ibid., P. IV-10.

In July 1977 CG, Military Personnel Center (MILPERCEN) instituted the requirement for a MILPERCEN Initial Recruit and Training (MIRAT) Plan for systems acquisitions. The MIRAT would, through a process of backward planning, identify the quantitative and qualitative requirements and the sequence with which events would have to occur to ensure that personnel would be available in a timely fashion for fielding new materiel systems. The XM1 was dedicated as a test case and a MIRAT Plan published in October 1977 and revised in March 1978.¹²²

Among the assumptions listed to support the MIRAT Plan are:

- (1) The XM1 Tank will replace M60 Tanks on a one-for-one basis, therefore there will be no change in the total number of personnel required.
- (2) Qualifications of soldiers selected for training on the XM1 Tank will be the same as those required for training on the M60 Tanks.
- (3) XM1 trained personnel must be available as individual replacements to XM1 units subsequent to July 1981.
- (4) Equipment will be available to start resident training at USAARMC and USAOCCS in January 1981.
- (5) New MOSs will be required for the XM1 Tank Driver, Tank Crewman, Tank Turret Mechanic, and Track Vehicle Mechanic.
- (6) No new MOS will be required for DS/GS maintenance.

¹²² MILPERCEN, MILPERCEN Initial Recruit and Training Plan for XM1 Tank System (U), Alexandria, VA: 20 October 1977 (Updated 30 March 1978). (CONFIDENTIAL)

Among the MIRAT Plan's conclusions are:

- (1) Current lead time exists to ensure personnel support for the XM1 Tank when fielded.
- (2) MIRAT assumptions need careful monitoring, especially (2) and (6) above.
- (3) The revised distribution plan (i.e. concurrent CONUS/Europe fielding) should preclude significant readiness or sustaining base problems.
- (4) It is critical that TRADOC identify the training requirements early in the development of a new materiel system to enable timely input for funding.

An Amended QQPRI (AQQPRI) was staffed by Tank Automotive Materiel Readiness Command (TARCOM) in December 1977.¹²³ It was endorsed by the Materiel Readiness Support Agency (MRSA) in February 1978. TRADOC elements, however, expressed some dissatisfaction. USAOCCS commented:

"Organizational and Direct Support MACRIT data and training information cannot be provided at this time for subject equipment. The AQQPRI does not provide sufficient information upon which to comment on the MOS selected or the AMMH."¹²⁴

The Logistics Center responded:

"The AQQPRI does not reflect sufficient information on the XM1 components and subcomponents to determine a workload for each MOS."¹²⁵

¹²³ Memorandum from TARCOM, dated 9 December 1977. Subject: Amended Qualitative and Quantitative Personnel Requirements Information (AQQPRI) for XM1 Tank, Combat, Full Tracked NETP No. TAR-7.

¹²⁴ Memorandum from USAOCCS, dated 30 March 1978. Subject: Amended Qualitative and Quantitative Personnel Requirements Information (AQQPRI) for XM1 Tank, Combat, Full Tracked, NETP No. TAR-7.

¹²⁵ Memorandum from LOGC to CG, TRADOC, dated 3 May 1978. Subject: Amended Qualitative and Quantitative Personnel Requirements Information (AQQPRI) for XM1 Tank, Combat, Full Tracked, NETP No. TAR-7.

The Combined Arms Center concurred in April and HQ TRADOC concurred in June 1978.

In September MILPERCEN noted that the AQQPRI was not in consonance with the TFMG recommendations for system specific MOSSs.¹²⁶ In October DDCSPER criticized TRADOC for incompleteness of training information.¹²⁷ In the meantime, MILPERCEN proceeded to negotiate a Tentative MOS (TMOS) Decision in August 1978, which was published in October 1978 as shown in Figure 4-14.¹²⁸ The TMOS announcement was caveated:

"It is emphasized that this is a tentative MOS decision and therefore cannot be used as a basis for the classification and identification of positions/personnel involved in the operation or maintenance of the XM1 tank."¹²⁹

In December 1978 the BOIP was amended to reflect the TMOS Decision.¹³⁰

¹²⁶ Memorandum from COL Schurz, MILPERCEN, dated 18 September 1978.
Subject: Amended Qualitative and Quantitative Personnel Requirements Information (AQQPRI) for XM1 Tank, Combat, Full Tracked, NETP No. TAR-7.

¹²⁷ Memorandum from LTC Lawton, DDCSPER, dated 10 October 1978.
Subject: Amended Qualitative and Quantitative Personnel Requirements Information (AQQPRI) for XM1 Tank, Combat, Full Tracked, NETP No. TAR-7.

¹²⁸ Source: MIRAT, op. cit.

¹²⁹ Memorandum from COL Schurz, MILPERCEN, dated 16 October 1978.
Subject: Amended Qualitative and Quantitative Personnel Requirements Information (AQQPRI) for XM1 Tank, Combat, Full Tracked, NETP No. TAR-7.

¹³⁰ Memorandum from COL Schurz, MILPERCEN, dated 4 December 1978.
Subject: Amended Qualitative and Quantitative Personnel Requirements Information (AQQPRI) for XM1 Tank, Full Tracked, NETP No. TAR-7.

OPERATION:

Officer - ASI 3D XM1 Tank
Enlisted - MOS 19K XM1 Armor Crewman
19L XM1 Tank Driver

ORGANIZATIONAL MAINTENANCE:

Warrant Officer - MOS 630A Automotive Repair Technician
Enlisted - MOS 63E XM1 Chassis/Systems Mechanic
45E XM1 Turret Mechanic (includes light weapons and
chemical equipment)
31V Tactical Communication Systems Mechanic

DIRECT AND GENERAL SUPPORT:

Warrant Officer - MOS 630A Automotive Repair Technician
Enlisted - MOS 31E Field Radio Repairer
34G Fire Control Computer Repairer w/SQI "T"
35B Electronic Instrument Repairer
35E Special Electrical Devices Repairer
41C Fire Control Instrument Repairman w/SQI "T"
45B Small Arms Repairman
45K Tank Turret Repairman w/ASI "L8" XM1 Turret
Repair
54D Chemical Equipment Repairman
63G Fuel and Electrical System Repairman w/SQI "T"
63H Automotive Repairman w/SQI "T"

SOURCE: MIRAT PLAN, JULY 1979

FIGURE 4-14 XM1 TENTATIVE MOS DECISION.

In October 1978 the PMO provided input for the Final QQPRI (FQQPRI) to TARCOM. This input was essentially the same AMMH provided in the AQQPRI. The PMO noted:

"This reflects an engineering estimate based on M60A1 experience and the XM1 Materiel Need. This data is not considered adequate for current requirements."¹³¹

In November TSM XM1 requested additional LSA/LSAR data to support the QQPRI.¹³² The PMO replied that the LSAR have not been updated because "PT/ME does not accurately reflect field maintenance time." Because there were "problems" with using TECOM and OTEA data, the PMO planned to host a maintenance data evaluation workshop in February 1979. The PMO proposed a solution:

"It is recommended that consideration be given to initially fielding the XM1 using current TOE authorizations for personnel. After a period of field experience, AMMH could then be computed based on actual data and used to amend TOE's."¹³³

MILPERCEN was becoming increasingly concerned with the upcoming fielding dates. Since there was to be no more data until DT/OT III, they proposed proceeding with the Final MOS Decision in July 1979, rather than February 1980. This would allow them to proceed with their planning.¹³⁴

The PMO urged the approval of the FQQPRI based on M60 Series data.

¹³¹ Msg. 151230Z from PMO XM1, DRCPM-GCM-L to TSM XM1, ATZK-XM1, dated 15 December 1978. Subject: XM1 Logistic Support Analysis Records (LSAR).

¹³² Msg. 281638Z, op. cit.

¹³³ Msg. 151230Z, op. cit.

¹³⁴ Based on interviews by the study team with staff members of the Military Occupational Development Division, MILPERCEN.

"Sufficient information on functions performed by personnel operating or supporting the XM1 is available which identifies appropriate MOS's for such functions. This qualitative information has been widely disseminated to service schools and other interested activities in the form of equipment manuals and the XM1 Task and Skill Analysis (TASA)....Currently available data is inadequate for determination of AMMH which would justify any increase or decrease of TOE manpower authorizations....AMMH data will be collected and be available 3QFY81."135

The PMO admitted that the maintenance evaluation workshop had failed to produce acceptable AMMH.

"Unrepresentative failure rates from DT/OT II data prevented the generation of AMMH from the workshop...the achieved maintenance ratio demonstrated to date by the XM1...is within the range of the M60 fielded fleet."136

Staff members in HQ TRADOC, Directorate of Organization were urging the rejection of the FQOPRI on the grounds that it had no validity.137 They were overruled so that the program could be kept on schedule. On 5 June 1979 HQ TRADOC concurred "with this exception

135 Msg 031250Z from PMO XM1, DRCPM-GCM-L, dated 3 May 1979.
Subject: XM1 Tank Final QOPRI.

136 Memorandum from LTC R. T. Walker, PMO XM1, dated 16 May 1979.
Subject: Final Qualitative and Quantitative Personnel Requirements Information (FQOPRI).

137 Based on interviews by the study team with staff members of the Directorate of Organization, HQ TRADOC.

to policy as an interim measure pending receipt of an amended FQOPRI.¹³⁸ However, the FQOPRI was not sent to HQDA for approval.

In May and June 1979 MILPERCEN updated the MIRAT Plan. Some significant changes in assumptions had occurred:

"...there will be no change in the total number of personnel required to crew the vehicle.

"Logistic supportability, ammunition and fuel, together with proposed changes in support doctrine will necessitate a large manpower increase. Those increases have not been firmly established, however, it appears that the Army-wide total will be approximately 1700 spaces at the organizational level.¹³⁹

...Final DS/GS maintenance manpower requirements for the XM1 system will be developed after DT/OT III data are analyzed (Feb 81).¹⁴⁰

The earlier MIRAT conclusion that "current lead time exists to ensure personnel support for the XM1 Tank when fielded" was dropped from the list of conclusions in the update. The new plan concluded that if personnel are to be available when the XM1 is fielded, the

¹³⁸ Memorandum from LTC Danielson, HQ TRADOC to PM XM1, dated 5 June 1979. Subject: Final Qualitative and Quantitative Personnel Requirements Information (FQOPRI).

¹³⁹ This is a very controversial figure. The analysis supporting it was generated by the TSM Office. PM XM1 is resisting any increased figures. In interviews OCSA staffers have estimated 1300, MILPERCEN as high as 2000.

¹⁴⁰ MILPERCEN, MILPERCEN Initial Recruit and Training Plan for XM1 Tank System(U). Alexandria, VA: 31 May 1979 (Updated 20 June 1979) (CONFIDENTIAL). Tab B.

logistic support requirements must be finalized no later than 4QFY79.¹⁴¹ However, the plan assumes that logistic support data will not be finalized until after DT/OT III in February 1981.¹⁴²

4.7.3 Cost and Operational Effectiveness Analysis

In 1978 USAARMC initiated an update of the 1976 COEA to support ASARC/DSARC III.¹⁴³ The primary purpose of the COEA Update was to identify any changes to system performance since the previous study and analyze their impact. The study alternatives were the XM1, the M60A3, and the M60A1AOS; the last served as the base case. The study concluded that the findings of the earlier COEA remained valid.

The COEA Updated included as an appendix the "Modified Preliminary CTEA on the XM1 System Training Devices (Less Maintenance)."¹⁴⁴ Three XM1 System Devices were examined: U-COFT, OSUT-COFT, and Driver Trainer. No maintenance training devices were examined. Three non-system training devices were also analyzed: Tank Weapons Gunnery Simulation System (TWGSS), Combat Training Theater (CTT), and Tank Appended Crew Evaluation Device (TACED).

The most critical assumption made by the CTEA was:

"The training device effectiveness is comparable to that of the XM1 Tank System and has the capability to substitute accordingly if the training device meets the requirements of the TDR/LOA¹⁴⁵ (Equal Effectiveness of Alternatives)."

The effectiveness analysis was limited to a determination of what tasks were covered by each device in each training setting. Given the equal effectiveness assumption, the cost-effectiveness

¹⁴¹ Ibid., Tab I.

¹⁴² Ibid.

¹⁴³ US Army Armor Center, XM1 Cost and Operational Effectiveness Analysis Update (U). Fort Knox, KY: 1 March 1979. (4 Volumes) (SECRET/NOFORN)

¹⁴⁴ Ibid., Vol. IV, Part 2, App. I.

¹⁴⁵ Ibid., p. I-5.

analysis was accomplished by a cost analysis. The CTEA recommended continuation of the development of the XM1 system devices and the TWGSS, and further analysis of the CTT; it questioned the requirement for the TACED.

4.8 PRODUCTION DECISION

ASARC III and DSARC III had originally been scheduled for August 1978. The revised schedule prepared after the DSARC II had slipped them to February and March 1979, respectively. This schedule was slipped one month further.

The key question to emerge for ASARC III was the logistic supportability of XM1. Both the Army's Logistician, LEA, and the Congress' watchdog, GAO, were concerned with this issue.

In preparation for ASARC III, the Human Engineering Laboratory (HEL) and the Medical Research and Development Command (MRDC) prepared a Human Factors Engineering Analysis (HFEA).¹⁴⁶ Most of the evaluations of the HFEA of interest to this study have been discussed in previous sections of this report. The HFEA did conclude that, in spite of some deficiencies, the XM1 was probably the best human engineered American fighting vehicle.

4.8.1 LEA Interim Assessment

To assist the DCSLOG in formulating his position for ASARC III, LEA prepared an interim assessment of the XM1 from the logistician's viewpoint.¹⁴⁷ The assessment was performed in late 1978, before the completion of OT II, and published in January 1979.

Although much of the LEA report covered areas outside the scope of this study, a number of related issues were discussed. Comments on DT/OT II and the QQPRI were previously discussed in Subsections 4.6 and 4.7 above.

Three critical skills areas were identified: the fire control computer repairman (MOS 34G), vehicle mechanics (CMF63), and turbine engine repair. The introduction of the XM1 will bring additional duties to the 34G and CMF63. LEA feared that these additional duties would be too much for the personnel to handle and urged expeditious implementation of plans to alleviate the situation. The final MOS decision made no provision for a turbine engine repairman. The issue, however, was still unresolved.

¹⁴⁶ HEL/MRDC, op. cit.

¹⁴⁷ LEA, op. cit.

LEA noted in particular the positive impact of the TSM and USAOC&S on logistic support development, training, and logistic test evaluation. The TSM was described as the leader in attempting to refine the maintenance concept.

In the area of training programs, LEA noted that USAOCCS lagged behind the USAARMC. This was ascribed primarily to the lack of a finalized Maintenance Allocation Chart (MAC), too little hardware being allocated to support training development, and lack of functioning test sets.

The significant lag in training devices was noted. The availability of devices at DT/OT III was doubtful and no development plan for training devices was available. In addition, a funding shortfall of \$100 million for training devices had been identified by the TSM.

LEA noted that no plans had been made to provide additional facilities for training devices, nor had existing facilities capabilities been incorporated in device design requirements. Since there is a five year lead time on new construction, LEA concluded that this item was behind schedule.

The report assessed Draft Equipment Publications (DEPs) as "substandard in regard to completeness and accuracy."¹⁴⁸ Constant changes to the tank configuration has led to continuous changes to the manuals. More than half of the over 10,000 pages of TMs had been changed at least once.

"The SPA concept remains valid; however, successful implementation of that concept requires that a significant effort be put forth to validate the TMs. That significant effort has not been applied to the XM1 to date. Furthermore, future time scheduled and equipment allocated will not allow a complete validation prior to fielding."¹⁴⁹

¹⁴⁸ Ibid., p. 18.

¹⁴⁹ Ibid.

In its conclusions the LEA report notes that:

"The basic policy for systems acquisition is that the pacing factor shall be the successful attainment of objectives rather than scheduled milestones....The contention that significant deficiencies can be corrected and later verified in the next phase should not be permitted."¹⁵⁰

LEA concluded that the XM1 was not ready to enter Low Rate Initial Production (LRIP), but should, instead, continue in FSED with further testing.

"Significant engineering development phase effort remains to be accomplished and demonstrated to allow logistic supportability to attain a status commensurate with the end item tank....Projected successful fielding, approaching the goal of zero logistics support problems, on the current program schedule is not considered attainable."¹⁵¹

When the LEA position was briefed to the DCSLOG on 16 January 1979, he directed that a letter be drafted to CG, DARCOM indicating that the XM1 should stay in FSED. This, however, was postponed to allow time for PM XM1 to reply.¹⁵²

The PMO replied with detailed comments on 26 January,¹⁵³ which in turn led to an LEA response.¹⁵⁴ To a large extent the PMO

¹⁵⁰ Ibid., p. 25.

¹⁵¹ Ibid., p. 29.

¹⁵² Memorandum for SMT from MG Alan A. Nord, Director of Supply and Maintenance, ODCSLOG, dated 17 January 1979. Subject: Logistic Supportability of the XM-1 Tank.

¹⁵³ Letter from COL Herman J. Vetort, Deputy PM XM1 to MG Alan A. Nord, dated 26 January 1979 with Enclosure: "LEA XM1 ILS Program Review (Draft), 2 January 1979: Summary of XM1 PMO Staff Comments."

¹⁵⁴ LEA, "Evaluation of PMO Reply to USALEA XM1 Program Review (Draft) Report." Undated (c. Feb. 1979). (FOR OFFICIAL USE ONLY)

position is that considering the severe constraints that the program was under and the time remaining before European Operational Capability (EOC), the program status was satisfactory. Specifically, the PMO stated:

- "a. The LEA draft report which weighs the status of XM1 logistics development, does not appear to consider the following:
 - "(1) Fiscal constraints and DA/DoD/OMB approved funding ceilings for the program.
 - "(2) The congressionally mandated 'seven years from program inception to fielding.' This severe schedule constraint requires the materiel developer and supporting organizations to modify desirable head-to-toe procedures as prescribed by doctrine.
 - "(3) The approved Army program for development of the XM1 did not fully fund the development of logistical support in the validation phase when two contractors, Chrysler and General Motors, were in competition. This decision was driven by the desire to conserve funds and resulted in logistical support development lagging development of the tank by one phase at the time of FSED contract award. The XM1 program is structured to correct this lag by the EOC (European Operational Capability) milestone in 1981 and not by the IOC (Initial Operational Capability) milestone in 1980.
 - "(4) The XM1 logistical support concept is designed to field the tank in 1981 without requiring contractor logistical support. This decision was made considering the density of tanks to be supported, their forward location, and their dispersion along the front. This requires a more ambitious logistics development program which inherently generates problems in scheduling, funding and management. Most other major Army weapon system development programs rely heavily on

contractor logistical support in initial years of fielding.

- "b. The report appears to evaluate the XM1 program against a goal of zero logistics problems in terms of the doctrine described by the current AR 1000-1. This current doctrine does not assume a DT/OT III test or a decision milestone IIIa. In fact, the XM1 program is based on doctrine established by a prior AR 1000-1 and the corresponding Life Cycle Management Model. This additional development phase will be used to verify correction of problems surfaced in the XM1 PT/ME and DT/OT II."¹⁵⁵

LEA's response reasserted its position, judging the program in terms of goals established by regulation and by program documentation.¹⁵⁶

Some of the specific PMO and LEA comments have been discussed in previous sections of this report. Of particular interest is the PMO's statement:

"It was never planned to have prototype training devices available for DT/OT II. The original development schedule for the devices scheduled prototypes for delivery in time to support DT/OT III. Current PM TRADE schedules indicate that this will not happen with the possible exception of the maintenance troubleshooting trainers...The XM1 training devices, while highly desirable, are not essential to OT III in 1980 or fielding in 1981."¹⁵⁷

LEA noted that the introduction of training devices after fielding would create "turmoil" and that the "cost implication of this redirection could be significant."¹⁵⁸

¹⁵⁵ Vetort, op. cit., p. 1.

¹⁵⁶ LEA, "Evaluation of PMO Reply," op. cit.

¹⁵⁷ Vetort, op. cit.

¹⁵⁸ LEA, "Evaluation of PMO Reply," op. cit., p. 5.

The PMO noted that training device users were aware of the facilities requirements and would be able to handle any problems. LEA agreed that they could "probably compensate."

4.8.2 Logistics Readiness Review

With ASARC III rapidly approaching, HQDA recognized that action was needed quickly. The Tank Forces Management Office (TFMO) in OCSA requested ~~that~~ positive action be taken to reconcile the LEA and PMO viewpoints.¹⁵⁹

Meanwhile, the PMO had requested HQ DARCOM to establish a Logistics Readiness Review (LRR) Committee to assess whether the risk associated with XM1 logistical development was consistent with a decision to begin LRIP and whether fielding could be adequately supported in 1981. HQ DARCOM provided a chairman and advisory council to conduct the study. The PMO provided the study director. Functional teams composed of personnel from DARCOM, TRADOC, and HQDA and their subordinate agencies were formed to examine five specific areas:

1. Personnel and Training
2. Maintainability and Transportability
3. Support Equipment
4. Repair Parts Support
5. Funding.

The functional teams consisted primarily of DARCOM personnel (about 80%). The Personnel and Training Team was chaired by the TSM. A report was issued in February 1979.¹⁶⁰

¹⁵⁹ Memorandum for the Director of Supply and Maintenance, ODCSLOG from MG Richard D. Lawrence, Chief/TFMO, dated 19 January 1979. Subject: XM1 Integrated Logistic Support (ILS) Program.

¹⁶⁰ HQ DARCOM, XM1 Tank System Logistics Readiness Review Report. February 1979. (FOR OFFICIAL USE ONLY)
Volume I: Executive Summary
Volume II: Detailed Team Reports
Volume III: LRP Plan and After-Action Report

The LRR concentrated on the XM1's potential for improvement before fielding. The Executive Summary concluded that the current schedule should be kept intact. Although some significant problems existed, the LRR felt that appropriate actions were available to the Army in each case, except for funding shortfalls.

In the area of personnel and training, the Executive Summary identified some significant strengths:

"FSED assets have been dedicated to training support. The current version of the operator's manual is considerably improved. Maintenance training devices are being developed by a contractor who has extensive experience with similar trainers. Personnel skills have been adequately identified. A DA-approved ICTP is presently in existence. Operator and organizational maintenance training packages have been successfully used in training OT II participants. Manpower requirements for crew and POL and ammunition support have been determined."¹⁶¹

Medium risk was assigned to personnel, publications, and training devices. It was noted that the COFT was two years behind schedule.

"The school can absorb the resulting impact by more intensive use of tanks and subcaliber devices. For those XM1-equipped units without ready access to laser-safe ranges, there is no real substitute for the unit conduct-of-fire trainer."¹⁶²

Training materials were assessed as high risk, primarily due to test set problems.

The functional team reports, which served as input to the LRR, were published as well. The Personnel and Training Team Report assigned a high risk to the development of training materials.

¹⁶¹ Ibid., Vol I, pg. 4.

¹⁶² Ibid., p. 5.

"...the problems identified are considered to be potentially disruptive to the successful and initial fielding. Additionally,...the failure to provide adequate planning and support in one area could result¹⁶³ in serious degradation in all other areas."

Problems in the development of training materials are generally ascribed to the instability of the design of the tank and support equipment.

High risk was assigned to publication development (SPA), which poses medium risk for successful fielding. Problems in this area were generally ascribed to:

1. Poor contractor responsiveness and quality control
2. Frequent design changes
3. Lack of access to hardware
4. Lack of a firm DARCOM/TRADOC policy on SPA target audience.

"It is impossible, even if hardware is made available, to produce DA-printed and distributed publications within the present timeframe for fielding. It is also questionable if 100 percent contractor validated and government verified drafts could be provided by the European fielding date.

"Whatever adjustments are made to accommodate validation and verification, they will have a significant effect on funding, facility, and manpower resources of TRADOC and DARCOM. It is impossible to identify the exact impact at this time, but current estimates indicate a minimum of one year would

¹⁶³ Ibid., Vol. II, p. 7.

be required at both Aberdeen Proving Ground and Fort Knox. This will require that contractor personnel, target audience soldiers and TRADOC and DARCOM monitors be at both sites for that time frame.

"The troubleshooting manuals, based on use of test sets, may not be completed in time for inclusion in the manuals for European fielding. This problem is caused by the present unreliability of some of the test sets and indications that these problems may not be resolved until late in 1980. The result will be an inability to isolate faults for repair.

"Due to the numerous engineering changes during the FSED phase, the Extension Training Materials (ETM) developed to date do not cover all task procedures that may ultimately be considered for ETM coverage. There is at present no firm TRADOC plan to identify and develop the remaining ETM requirement. The result will be that the ETM package will probably be incomplete when the tank is fielded."¹⁶⁴

Four critical problem areas were identified for the COFT:

"Facilities. UNIT-COFTs are planned for installations supporting armor battalions and armored cavalry squadrons. Already cramped for space, where is the installation commander going to place this complex training device that will require over 200 square feet of floor space?...

"Qualified Instructors. If the facilities are available to house the UNIT-COFT, who is going to be the instructor? Neither the typical tank commander nor the typical training NCO is

¹⁶⁴ Ibid., pp. 11-12.

qualified to operate the device....The individual selected to be an instructor must be qualified as an instructor, must be a qualified tank commander, and must be a technician. This type of individual will be very difficult to find in a battalion size unit.

"Field Maintainability. Continuous on site contractor maintenance support will be prohibitively expensive. On-call contractor maintenance support will not be responsive enough. Therefore, it falls back to the instructor to be able to detect faults, perform fault isolation, and to remove and replace faulty components. These are not the normal qualifications of either a tank commander or a training NCO.

"Availability for Training. The current schedule assumes the production award for the UNIT-COFT will be made in April 1981. Based on the current solicitation requirements and the program risks, delivery of the first production unit cannot be expected prior to May 1982. This is almost a full year after the XM1 is fielded. The OSUT-COFT will not be available for training for almost 3 years after the start of institutional training."¹⁶⁵

The reports noted that the AMMH data "is considered suspect by numerous agencies because it is derived from estimations based on experience with other tank systems."¹⁶⁶ The report concluded, however, that the QQPRI impact was low risk.

"The AMMH in the AQQPRI, was generated by estimation in the early stages of the XM1 program and are not considered adequate for current purposes. AMMH is not available in a

¹⁶⁵ Ibid., pp. 31-32.

¹⁶⁶ Ibid., p. 36.

timely and updated manner from the contractor. PMO XM1 is conducting a maintenance data analysis to produce a refined estimate of AMMH for the FQPRI. This analysis includes the application of the Delphi technique by a group of experienced XM1 maintenance personnel to DT/OT II empirical data. This process should produce adequate AMMH data for input to the FQPRI and final MOS decision. QPRI AMMH information is considered a moderate risk area."¹⁶⁷

"The Team Captain's overall assessment was that time, XM1 quantities/availability and funding constraints will preclude the complete resolution of the problems identified in this report prior to fielding the XM1. An overall risk assessment of medium is assigned the functional area in terms of fielding the XM1 tank as a complete system in 1981..."¹⁶⁸

LEA responded to the LRR on 16 March 1979. Their positions were unchanged. High risk was assigned to system maturity, maintenance plan, support and test equipment, supply support,¹⁶⁹ and technical data. Personnel and training was assigned medium risk.

After reviewing the LEA position and the LRR, the DCSLOG concluded that there was sufficient potential for improvement in the XM1 to warrant entering LRIP.¹⁷⁰

4.8.3 ASARC III

ASARC III met on 22 March 1979. It recommended that the Army's position be that the XM1 enter LRIP.

¹⁶⁷ Ibid., p. 39. (The maintenance data analysis using the Delphi technique was a failure; see p. 4-77 above.)

¹⁶⁸ Ibid., p. 2.

¹⁶⁹ LEA, "XM1 Tank Comparative Assessments." 16 March 1979 (FOR OFFICIAL USE ONLY).

¹⁷⁰ Based on interviews by the study team with the DCSLOG staff.

SECTION V SENIOR SCIENTISTS BOARD BRIEFING

The keystone of the research method is the briefing to the Senior Scientists Board (SSB). As an "event," it cannot be fully captured in a report, but this section attempts to relate as much of its essential elements as possible. Three of these elements appear to be key: the differing organizational perspectives represented by the advocates, the opportunity to view the total system development of XM1 at one time, and the guidance given the study team by the SSB. These three points are discussed in order in the the three major subsections.

5.1 ADVOCATES SUMMARIES

During the briefing to the board, each advocate assumed the point of view of the agencies he represented (essentially, a role-playing approach). While the interplay among the advocates during the audit trace cannot be captured in the report, each advocate was asked to prepare a brief statement from his (role-playing) viewpoint of the problems of the XM1 program and how they relate to the LCSMM.

5.1.1 Proponent--TRADOC

As the User's Representative, TRADOC, more than any other advocacy position, contains a multiplicity of organizational perspectives. TRADOC--or rather components of TRADOC--represent both the combat arms and logistic support and TRADOC is itself a user in its responsibility for institutional training.

TRADOC was caught between two cross-currents of systems development. One school of thought, dominated by the combat developers and especially prevalent in upper management, emphasized the need to keep the tank program on schedule and within cost. They argued that any slackening of the momentum of the program might lead to postponement or cancellation by the Congress (like the XM803) and that the requirement for a new tank was such that minor or temporary problems could be tolerated. The other school of thought, dominated by the logistic support community, emphasized the production of a tank with as few problems as possible. They argued that the LCSMM was an event-driven process and that the schedule should be subordinate to successful completion of events.

The focal point of TRADOC's efforts is the TSM. Although this position was not created until early 1977, the TSM has been an important force in defining and solving system problems. The position is an inherently difficult one. Although highly visible, the TSM has very limited resources to accomplish his mission and must rely primarily on his powers of persuasion. He is usually junior to or outranked by his DARCOM counterpart, the PM (in XM1 the TSM is a colonel, the PM a major general).

In theory, TRADOC is the driving force behind the system acquisition cycle. New programs are to be initiated based on TRADOC's continuing analysis of mission needs and continued based on TRADOC's definition and refinement of requirements and effectiveness evaluations. DARCOM's role is to be responsive to TRADOC's requirements.

In practice, the DARCOM PM is in the driver's seat once the program has been initiated. DARCOM's hardware development paces the system schedule. Should other parts of the program fall behind schedule, the PM continues on his own timetable.

In an effort to cut costs the DA approved program often chose to ignore TRADOC's requirements. For example, insufficient FSED tank prototypes were procured to support the development and validation of training materials and devices. Closer cooperation between DARCOM and TRADOC are required to ensure that TRADOC's requirements are met.

Of particular importance to TRADOC is the development of training programs (including devices). These are an integral part of the total system and need to be as thoroughly tested and evaluated as any other part of the weapon system. OTEA, however, has consistently refused to provide the necessary resources for OT testing of the training subsystem, claiming that it is outside their mission. Increased emphasis on the testing of training should be a future goal for the Army.

In general, it should be noted that period of XM1 development was a difficult one for TRADOC. The command was newly organized in 1972 and over the succeeding years was in the process of introducing new ideas and innovative practices, especially in the area of training. XM1 was chosen as the first major system upon which some of these ideas would be tried (e.g., SPA, TSM, high technology training devices). It was inevitable that some difficulties ensued. In the long run, the Army has developed more effective methods for manning and supporting its sophisticated weapons systems.

5.1.2 Materiel Developer--DARCOM

The XM1 program had to succeed. The MBT70 program had collapsed, and its successor, the XM803, had been cancelled by the Congress as being too costly and too complex. If the Army was to have a timely replacement for the aging M60 series, a program which would produce a tank on schedule and "on cost," as well as superior in performance, was essential. The MBT70/XM803 program had consumed ten years and significant funds with no result, while the threat increased in both quantity and quality. Recognizing the increasing threat, the Congress agreed to a new start and a seven year development program. At the same time a cost goal was established for the production vehicle. While it was recognized that seven years represented a short development period, delays would result in increased costs due to inflationary pressures, and open the door to those who would inevitably seek to cancel the program.

Two new requirements were also added -- a DOD design-to-unit-cost approach and a Congressionally mandated competition, the latter including the stricture--"keep your hands off Army and let American industry design a tank for you once you have given them the requirement." Thus the program in its early phase had to accommodate constraints of cost, schedule, competition, and performance.

Towards the end of the AD phase a new challenge appeared. Encouraged by internationalists in OSD, the FRG weighed in with its competitor--the Leopard 2. A new dimension was thus added to the program, to include a requirement to conduct a shoot-off between US, UK, and FRG tank guns, the last two in relatively early stages of development. Great thrashing about subsequently resulted in a US/FRG Memorandum of Understanding with regard to "harmonization" of tank development programs and, ultimately, assignment for production of selected components to one or the other country.

Throughout this phase, no change was made to program goals: cost, schedule, and performance. As FSED was completed, these goals remained valid. It was in this context that priorities were required, which were accordingly attached to the primary goals. Every effort was made to fulfill all requirements, to include personnel and training.

In specific terms, finalization of Training Device Requirements, a responsibility of TRADOC, was the only milestone not

met in the AD phase of this program. The PM repeatedly requested that this be accomplished to ensure that these requirements could be incorporated in the FSED RFP and the FY 77 budget, both actions being critical to keeping the training devices in step with the basic tank program. TRADOC, however, chose this time to reevaluate its entire training device program, to include proposing a number of concepts for XM1 devices, at least one of which would add appreciably to the cost of the tank. This entire situation was clearly unsatisfactory but could not be allowed to jeopardize the development schedule for the tank itself. Thus there was no choice but to proceed with the proviso that the training devices would catch up later in the program. A similar situation existed with respect to the QQPRI, again a TRADOC responsibility. The original XM1 Master Schedule called for submission by TRADOC to HQDA in September 1977. This has yet to be accomplished. MILPERCEN in this case also contributed to the problem by instituting a MIRAT Plan requirement for which, as usual, the XM1 program was selected as the test case.

In summary, it is difficult to understand how those responsible for the personnel and training subsystems could not themselves understand that expeditious action was required to support the Army's priority development program. Major wide-ranging reevaluations, soul searching, and test case programs were not appropriate to the task at hand. Recognizing that his priorities remained cost, schedule, and performance for the basic tank, the PM made every effort to ensure that personnel and training matters were properly addressed. If, however, agencies working those problems were unable to keep to the DA-approved Master Plan, the development program would proceed without them, making temporary accommodations until catch up actions could be completed in later stages.

5.1.3 Operational Tester--OTEA

A review of the information and data collected for the study indicates several areas which appear to warrant further discussion and/or clarification.

5.1.3.1 Test and Evaluation

A major system, such as the XM1, will require extensive testing involving considerable time, money and other resources. It is interesting to note that there is considerable discussion of operational test and evaluation (OT&E) and relatively little concerning other testing. Some specific points on this are as follows:

OTEA was designated by DCSOPS as the operational tester of the XM1. This is clearly OT&E of the XM1 system.

OTEA was not designated as the operational tester of training, training devices, or other sub-systems. It was implied several times that training would be tested during XM1 OT II. While it is true that the OT II includes evaluating the capability of personnel to perform tasks given how they are trained under alternate training systems, this later type of training testing must be accomplished prior to OT of the system. It was also implied that training devices would be tested during the XM1 OT II. This is not feasible.

TRADOC was the designated operational tester for all training devices. The tasks were all scheduled to be conducted by organizations other than OTEA and at locations other than that used for XM1 OT II.

Developmental testing receives very little discussion concerning the XM1 and none concerning the training devices. Yet DT for the XM1, as for all major systems, consumes far more time and resources than does OT.

Training systems and training devices can well be addressed by Force Development Testing and Experimentation (FDTE). During the period of time considered, TRADOC has been heavily involved in major FDTE. It is suggested that FDTE is a most suitable vehicle to evaluate alternative training systems and training devices; these could provide the empirical data needed to make decisions.

5.1.3.2 Critical Issues.

The progress of a system through the materiel acquisition process can be directly correlated to the ability to answer critical issues. Personnel, training, and training device problems or potential problems must be identified as early as possible and included in the list of critical issues if they are to receive attention and priority. These issues and the criteria against which tests will be designed and data evaluated are developed in the Coordinated Test Program (CTP), which is a part of the Outline Acquisition Plan (OAP). These documents receive high level review and, after approval, provide the basic guidance for both DT and OT. The Independent Evaluation Plan (IEP), Test Design Plan (TDP), testing

and so forth are designed to answer the critical issues. Critical issues concerning personnel, training, and training devices and their impact on the system must be identified from the start in the documentation developed. Adding test requirements later/after the IEP, TDP, or Outline Test Plan have been prepared is very difficult and time consuming, as each requires extensive coordination.

5.1.3.3 Scheduling of DT and OT

OEA would prefer conduct of DT and OT in series as laid out in the LCSMM. However, concurrent DT and OT or even OT before DT does not invalidate the LCSMM as a model. In reality, all systems in the materiel acquisition process are resource limited in some way; the XM1 should not be considered unique. The LCSMM as an event-oriented model does not need to be changed to reflect resource constraints. Every system will be different, but the basic event related actions required to reach a given point do not change.

5.1.4 Logistician--LEA

The XM1 tank system development program as carried forward thru OT II testing did not alarm the logistic community until it became apparent to the Director of Supply and Maintenance, ODCSLOG, that extensive contractor involvement in maintenance during that testing could prejudice the evaluation of the maintenance test support package and the expectation of a fully-developed ILS concurrent with achievement of IOC. He conveyed this concern to OEA and the DCSLOG, who requested the interim assessment prepared by LEA in preparation for his participation in the DSARC III LRIP decision scheduled for March 1979.

When DSARC III was joined, the participants had been made aware of many of the compromises taken in compressing the standard development model for the XM1 system. Evidently, the decision to proceed with LRIP was taken based on other considerations than the logistics supportability issues aired. The Logistic Community was guided by the development plan, the management model, and the requirements of applicable Army Regulations governing the procurement process. The question is what can we learn from the sequence of events chronicled in this study to integrate logistic support into the development and fielding of a new major item of equipment more effectively?

Two candidate areas for possible improvement in the achievement of ILS with system IOC are those of (1) communication between the PMO and the logistic agencies responsible for ILS development and (2) the timing or initiation of support package development. Concerns in the first area include the low number of coordination meetings initiated by the PMO and the multiple agencies with responsibilities on the Log side. The second area recognizes political realities and suggests that Log agencies should spend no money in the anticipation of maintenance and support requirements for developmental systems until the design is firm, even if it means a crash program to make IOC.

5.1.5 Training Device Developer--PM TRADE

The concept of synchronizing the development of training devices with the development of the generation of weapons they will support has an obvious appeal. Training devices can alleviate the numerical requirement for weapons in support of training when the weapon is first introduced and therefore very scarce. They can help to have crews ready for the weapon in advance of actually being issued the weapon, making the weapon system operational more quickly after issue.

However, the synchronization of weapon development with training device development has very high inherent risks. The weapon system will necessarily be subject to redesign until the last test is complete. Even small redesign of system components may radically effect the nature of training devices. Large scale redesign of the weapon system may totally invalidate a simulator.

The LCSMM as a matter of philosophy requires training device requirements to be passed on to the training device developer at a stage when there are still very high risks of very significant design changes in the weapon system. Thus it implies acceptance of a risk of training device development being invalidated. This risk is considered necessary to have a training device available when the first weapons will be issued.

In the case of the XM1 this risk/availability tradeoff was demonstrated by the maintenance diagnostic test set simulators. An almost complete set of maintenance trainers was invalidated by a complete revision of the diagnostic test sets when the sets did not perform well in DT II and OT II. Therefore, a large design development effort was lost and the simulators will not be available

when the system is fielded. However, as costly an illustration of the hazards inherent in simultaneous development of training devices as the XM1 test set simulators provide, they are in general atypical of the training device problems most prevalent in the XM1 development.

Crew training simulator development fell several years behind the schedule called for in the LCSMM, not because of changes in XM1 design, but because the training community was at odds with itself as to what could be provided by simulator technology which was just then emerging.

At the time when the LCSMM called for TRADOC to draft a training device requirement the community was being influenced by new technology in computer-controlled, interactive simulated images. This technology was spreading outward from the aircraft industry and becoming more available due to the falling costs of small computer devices.

The debate within the community centered upon just how much of a revolution in simulators was possible over non-interactive projected image systems used previously. Computer controlled graphics could allow dynamic reaction of the simulator to trainee actions. However, it depended on schematic images which were not as realistic as projected photographic images.

The indecision within the training community was reinforced by the reluctance of the developer to ask for extensive funds for training devices at an early stage when procurement of the system itself is still in doubt. As a result training device requirements were held up for several years while a very basic decision about training devices was being worked out without benefit of prototypes.

The fact that this delay of several years did not cause exceptional concern to the overall managers of the XM1 system, underlines the comment that synchronized development of training devices and weapon system is viewed by many within the development community and by those who prepare budget requests as an unrealistic goal.

5.1.6 Executive Management--HQDA

When the XM1 program was first introduced in 1972, the then Army Chief of Staff, General Abrams, left no doubt in anyone's mind within the Department of Defense that this weapon system was and would

remain the Army's number one priority program until it was fully fielded. Although successive chiefs of staff have re-articulated General Abrams original position concerning the criticality of fielding an operationally effective and logistically supportable main battle tank, the original momentum that was established in the early 70's has noticeably slackened. A myriad of new programs have surfaced in the past seven to eight years, large and small, which have slowly but surely eroded the original "XM1 always comes first" philosophy. Specifically, the XM1 program office now finds itself competing with other program managers for already sparse personnel resources. Both MILPERCEN and DCSPER see no solution to the manpower crunch except to practice the "rob Peter to pay Paul" philosophy. Their management practice is self defeating, since the decade of the 80's finds the DA staff with too many "pauls" to support not only in the manpower areas but also materiel.

Because the Army was not able to fund an Integrated Logistics Support package as part of the initial XM1 program package, DCSLOG was reluctant to become involved in the early phases of the developmental cycle. The DCSLOG position was that logistics planning factors are difficult to develop and validate when the operational configuration of a weapon system is in a state of flux. DCSPER also found itself in the untenable position, early on in the program, of not having sufficient data both from an operations and logistics standpoint to develop a "personnel package" for their weapon system. Hindsight now affords us the ability to identify a lack of initiative by both the personnel and logistics staffs early in the program to use past experience and assumption to develop early "strawman" packages for their individual disciplines.

Since the manpower requirements were only recently finalized MILPERCEN will require additional time above and beyond normal lead time to ensure that the personnel pipeline can support a sustained flow of qualified personnel to operate and support this particular weapon system.

5.2 TIMELINES AND NETWORKS

The SSB briefing gave the participants the opportunity to review the entire XM1 development program at one time and to discuss with the advocates the communications networks used during the program. System timelines and interface networks are presented in this subsection to capture this aspect of the briefing.

5.2.1 Theoretical Timeline

As a baseline, a "theoretical timeline" for systems development was established by taking the current LCSMM (Cf. Section III) and assigning schedule dates for events in accordance with the LCSMM prescribed order. Since the LCSMM is completely event-oriented, several XM1 scheduled events were chosen to pace the system. The events chosen were the ASARCs, DSARCs, OTs and DTs, since these are generally the most difficult milestones to change.

Because of the compressed development schedule for XM1, it was not possible to avoid adjusting the ASARC/DSARC III date. Other milestone events were placed on the timeline in the order required by the LCSMM, keeping as close to the original XM1 schedule as possible. The results are contained in the first column of Figure 5-1. It should be noted that, since the theoretical timeline is based on the current LCSMM, it contains some events not required of the XM1 program.

Analysis of the theoretical timeline between DT/OT I and ASARC II and between DT/OT II and ASARC III shows that there could not be sufficient time under the compressed development schedule to complete key events relating to the QQPRI, the BOI, and training evaluation. Theoretically, these events require the data gathered during DT/OT, but must be completed prior to ASARC. It seems clear, then, that the compressed development schedule for XM1 and the LCSMM have some basic inconsistencies.

The theoretical timeline can be contrasted with the XM1 Master Schedule, which is shown in the second column of Figure 5-1. This schedule consists of the initial XM1 schedule up through ASARC II and the revised XM1 schedule established after DSARC II.

5.2.2 Subsystem Timelines

For each of the six advocacy positions a subsystem timeline was developed to trace the historical development of the XM1 program. These are presented in the last three columns of Figure 5-1. For convenience of presentation the HQDA, LEA, and OTEA timelines were compressed into one column and the PM TRADE timeline included under DARCOM.

¹ The change in schedule between ASARC II and DSARC II is due to the delay incurred to consider the Leopard 2, an event entirely exogenous to the issues considered by this study.

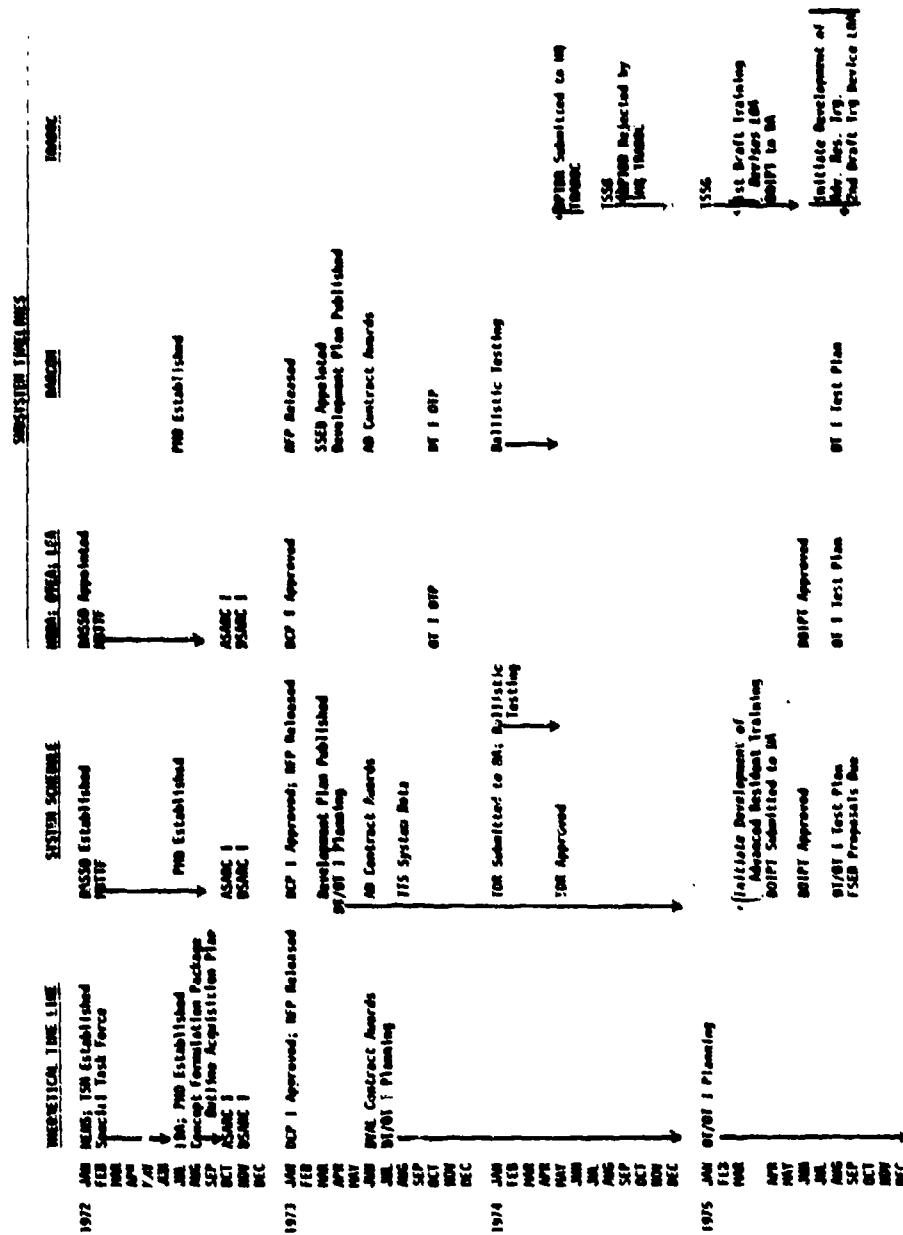


FIGURE 5-1. TIMELINES (PART 1 OF 2)

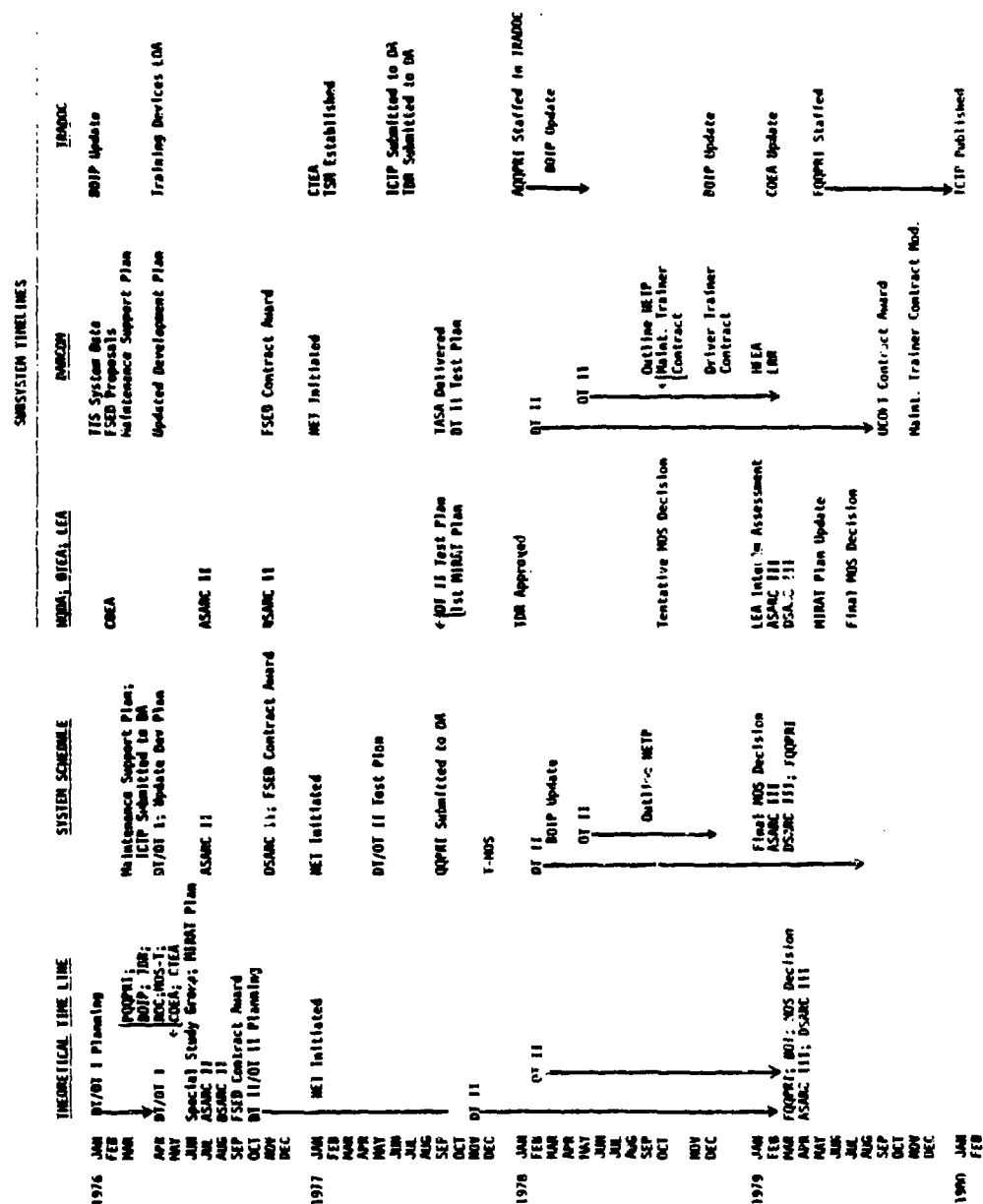


FIGURE 5-1. TIMELINES (PART 2 OF 2)

The most meaningful comparison of the columns of Figure 5-1 is between the System Schedule (column 2) and the Subsystem Timelines (columns 3, 4, and 5). In general, the XM1 program proceeded on or very near schedule, except in the personnel and training areas. The TDRs and the ICTP were submitted to DA for approval significantly later than scheduled. The AQQPRI was never submitted to DA for approval nor was the FQQPRI within the timeframe of this study.

5.2.3 Milestone Matrices

Timelines, however, do not present a complete picture of the progress of a program, since the entry of an event as completed does not necessarily imply that it was completed in a satisfactory manner. To gain another perspective the study team created milestone matrices.

Milestone Matrices were constructed by selecting five critical milestones (ASARC/DSARC I, DT/OT I, ASARC/DSARC II, DT/OT II, and ASARC/DSARC III) as the horizontal index and the advocates as the vertical index; the cell entries are the key documents that the advocate is to complete prior to the given milestone. Two milestone matrices were constructed. The theoretical milestone matrix (Figure 5-2) describes the requirements of the LCSMM. The empirical milestone matrix (Figure 5-3) describes the actual history of the XM1.

The most striking aspect of the comparison of Figures 5-2 and 5-3 is that the ASARC/DSARC II column of figure 5-2 is rather full and that of 5-3 completely empty. The reason appears to be that the timespan between DT/OT I and ASARC/DSARC II was so short that the events intended to be accomplished then were not. Events which somehow be done without DT/OT I data were completed prior to the test (BOIPT, Special Study Group, Revised MN(ED)), others were simply delayed. This is perhaps the most graphic portrayal of the conflict between the requirements of the LCSMM and the compressed development cycle.

The empirical milestone matrix also includes annotations to some events reflecting on their measure of success. Events which failed to accomplish significant goals or which contained deficiencies are noted.

The DARCOM-supplied support packages for DT II and OT II are considered by the study team to be seriously deficient in quality, primarily because of the problems associated with Chrysler's SPA

	ASARC/DSARC I	OT/DT I	ASARC/DSARC II	DT/OT II	ASARC/DSARC III
HQDA	Special Task Force Force Level Guid- ance ICPE DCP I		MOS Evaluation MIRAT Plan IPCE DCP II		MOS Decision DCP III
DARCOM	Logistic Support Planning Concept Formulation Package Outline Acquisition Plan (OAP)	Update OAP DT I Planning DT I Support Package OT I Support Package DT I Report	PQQPRI NETP Acquisition Plan	DT II Planning DT II Support Package OT II Support Package DT II Report	FQQPRI
TRADOC	MENS* Preliminary Opera- tional Concept Letter of Agreement COEA CTEA*	DT I Support Package OT I Support Package	BOIPT COEA ROC CTEA ICTP Special Study Group	DT II Support Package OT II Support Package	BOIP Draft TOE
OTEA		OT I Planning OT I Report		OT II Planning OT II Report	

* Products not required under then-current regulations for the XM1.

Figure 5-2. Theoretical Milestone Matrix

	ASARC/DSARC I	OT/DT I	ASARC/DSARC II	DT/OT II	ASARC/DSARC III
HQDA	MBTTF (=Special Task Force) (Force Level Guidance) ¹ (ICPE) ¹ DCP I	COEA		1st MIRAT Plan Tentative MOS Decision	DCP III
DARCOM	(Logistic Support Planning) ¹ (Concept Formulation) ¹ (Development Plan (DP)) ¹ (=OAP)	Update DP (=OAP) DT I Planning DT I Support Package OT I Support Package DT I Report		DT II Planning DT II Support Package ³ OT II Support Package ³ DT II Report ² TASA	AQPRI ³ NETP Training Devices Contracts HFEA
FRADOC	(Preliminary Operational Concept) ¹ (Training Requirements) ¹ (MN(ED)) ¹ (=LOA) (COEA) ¹	DT I Support Package OT I Support Package BOIPT and Update Tank Special Study Group Training Devices LOA Revised MN(ED) (=ROC)		ICTP Submitted TDR DT II Support Package OT II Support Package CTEA ²	COEA Update BOIP Update ³ Draft TOE
OTEA		OT I Planning OT I Report		OT II Planning OT II Report ²	

¹ Event accomplished by the MBTTF.

² Event which failed to accomplish some significant goals.

³ Product with some serious quality deficiencies.

Figure 5-3. Empirical Milestone Matrix.

package.² The DT II and OT II Reports are noted as failing to achieve significant goals, primarily because adequate data to determine AMMH was not collected. As a result of the failure to determine AMMH, both the AQQPRI and the BOIP Update are considered defective.⁴

The CTEA is noted as deficient because only one class of training device, the COFT, was ever closely examined for training effectiveness. Examination of the driver trainer and FCIS was at best cursory; and maintenance trainers were not examined at all.⁵

5.2.4 Interface Networks

The way in which organizations interface can, of course, seriously impact the efficiency with which work is accomplished. This principle is well illustrated in the XM1 program. The study team has chosen three examples which illustrate the range of interface networks employed during the XM1 program.

The first interface network typifies the procedures employed in staffing requirements for comment. The particular example chosen is the staffing of the Amended QQPRI to support the MOS decision. The network is illustrated in Figure 5-4. The process is essentially sequential and may result in lengthy delays. Figure 5-5 shows the progress of the AQQPRI through nearly a year of staffing.

Because of the pressure of time and schedule, some events could not tolerate processing by such a long and torturous route as that of Figure 5-4. DT/OT planning is such an event. To accommodate such events different types of interfaces are required. The TIWG structure, illustrated schematically in Figure 5-6, illustrates how test coordination is accomplished. All of the major participants in the test cycle met in committee on a regular and frequent basis to discuss and resolve problems in an expeditious manner.

The third type of interface to be considered concerns coordination with the contractors. During AD, only the PM and some selected PMO staff members were able to monitor the contractor due to

² Cf. Section IV, 4-62 to 4-65.

³ Cf. Section IV, 4-66 to 4-68.

⁴ Cf. Section IV, Paragraph 4.7.2.

⁵ Cf. Section IV, 4-42 to 4-43.

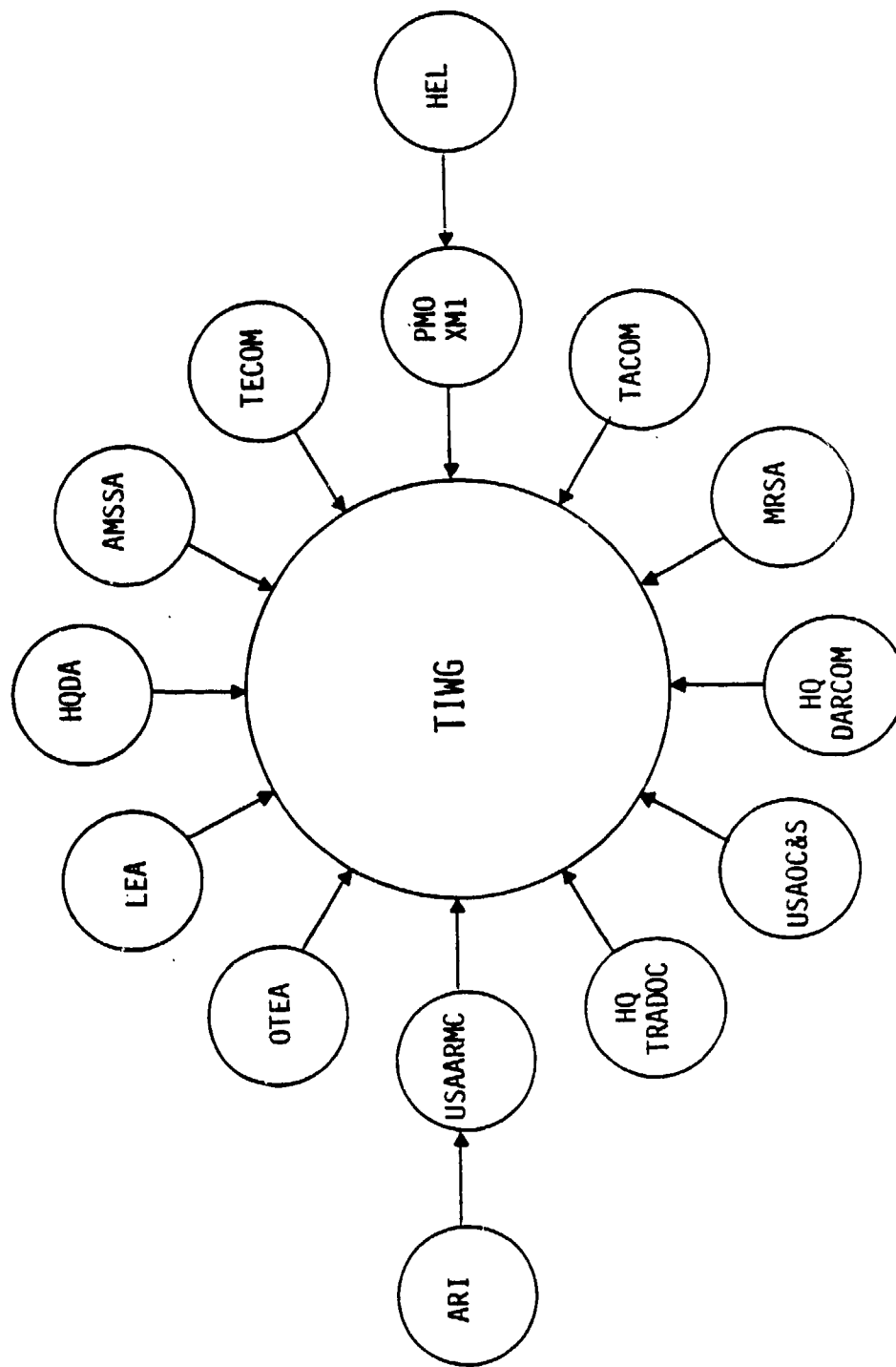


FIGURE 5-6. TEST COORDINATION

DATE	EVENT
9 DEC 77	Issued by TARCOM
7 FEB 78	Endorsed by MRSA
30 MAR 78	Comments by USAOC&S
26 APR 78	Endorsed by CAC
3 MAY 78	Comments by LOGC
28 JUN 78	Endorsed by HQ TRADOC
18 SEP 78	Comments by MILPERCEN
10 OCT 78	Comments by ODCSPER
16 OCT 78	Tentative MOS Decision
4 DEC 78	Revised MOS Decision

FIGURE 5-5. PROGRESS OF THE AQPRI

the competition sensitive nature of contractor plans. As illustrated in Figure 5-7(a), there was virtually no direct contact with the contractors. During FSED the PMO worked closely with Chrysler, but other Army agencies worked primarily through the PMO, as shown in Figure 5-7(b).

5.3 SSB DISCUSSION AND GUIDANCE

Following the SSB briefing, the SSB presented the advocates with a discussion of the briefing topics and guidance on the issues to be pursued. The discussion and guidance is documented in this subsection.

5.3.1 Acquisition System Problems

LCSMM is theoretically an event-driven model. In the case of the XM1 Program, it was driven primarily by hardware costs and schedule. Repeatedly, decisions were made to pass through scheduled XM1 events, although critical requirements had not been met, in the interests of hardware costs and schedule.

An example of the impact of schedule requirements can be found in the collection of Reliability, Availability, and Maintainability--Durability (RAM-D) data at Operational Test II. Because of the great difficulty encountered in keeping the prototypes running, contractor personnel were permitted to make critical modifications to the tanks, in order to minimize schedule slippages. As a result, inadequate data was available to estimate Annual Maintenance Man-Hours (AMMHs) with any degree of confidence. This, in turn, meant that maintenance manpower projections in the Qualitative and Quantitative Personnel Requirements Information (QQPRI) and the Basis of Issue Plan (BOIP) were very questionable.

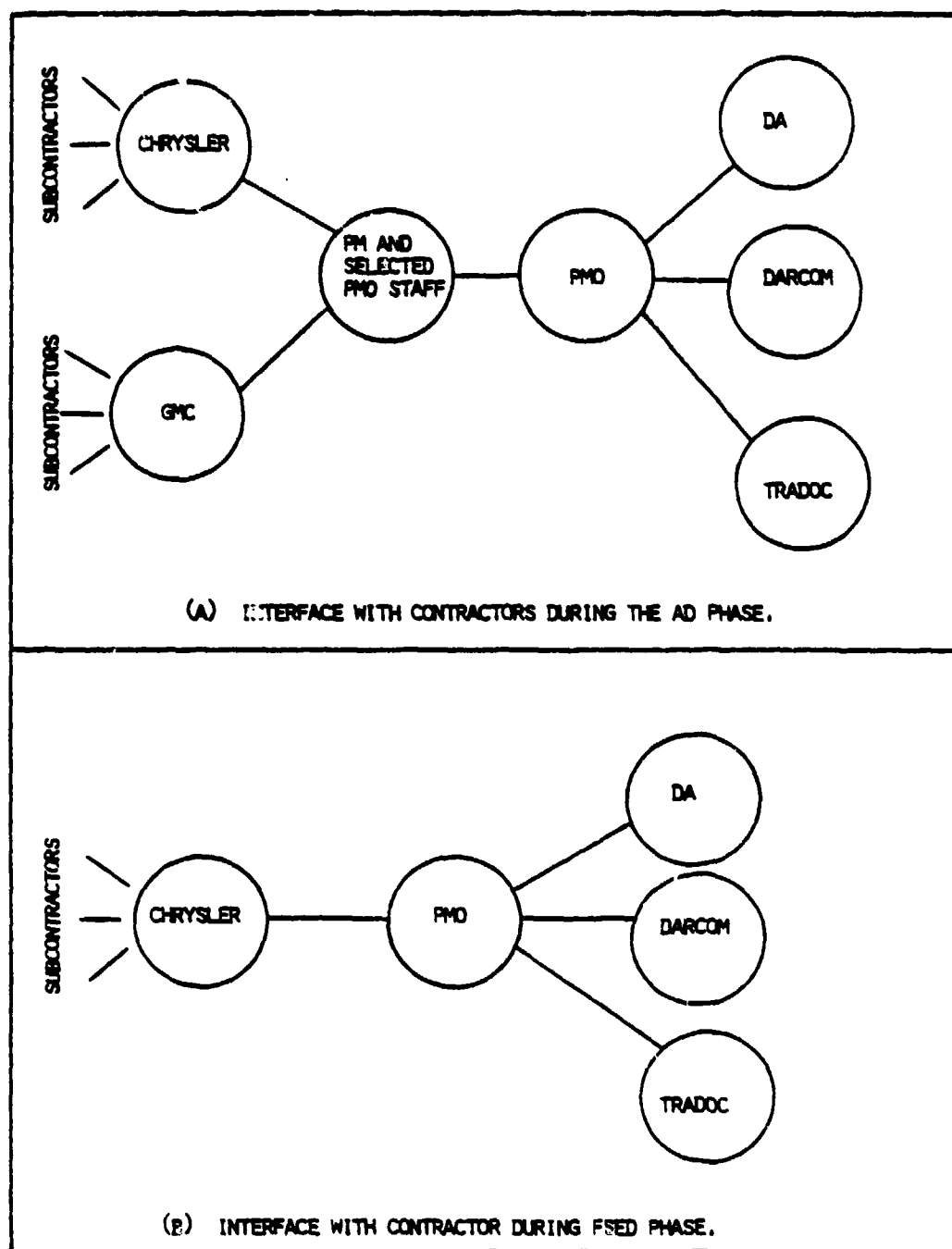


FIGURE 5-7. INTERFACE WITH CONTRACTORS

An example of the dominance of cost considerations can be found in the decision to omit the development of an Integrated Logistic Support (ILS) package during Advanced Development (AD) in order to save costs. Given the numerous subsequent problems associated with test sets, logistic support analysis records, and training materials, it is difficult to accept that the Army saved any money by omitting ILS requirements in AD; rather, it seems to have been a costly decision.

In general, the Army, the Defense Secretariat, and the Congress have shown little interest in ILS until very recently. Human dimension aspects of systems development lack the priority and visibility at the upper echelons of management to ensure adequate consideration. This, combined with the fact that human dimension issues tend to deal with long range impacts rather than immediate effects, makes the cutting or delaying of human dimension aspects attractive to hard pressed project managers.

An example of the lack of close scrutiny of ILS issues can be found in the decision made early in the program to have a 1500 hp engine in the XM1. Since the M60 has a 750 hp engine, it could have been observed at the beginning of XM1 development that adopting a 1500 hp engine (whether diesel or turbine) would likely result in increased fuel requirements, thus more fuel trucks and more fuel truck drivers. This was not done.

A good deal of this lack of interest can be traced to a poor understanding of how human dimension subsystems contribute to total system effectiveness. In the competition for program funds hardware developers have an impressive advantage through an array of analytical tools and data bases which relate their demands to system effectiveness. This ability to go directly to the "bottomline" has eluded personnel and training developers.

It is interesting to compare both the elaborate analysis and the high level attention given to the choice of the 105mm gun or the 120mm gun to the choice of the system training devices. An elaborate analysis of the firepower capabilities and the costs of the two guns was conducted and briefed to key DoD and congressional decision makers. Only a cursory analysis of the appropriate training devices was made, based primarily on subjective data. Many key decisions in the training device requirements development process were made without any major analyses being documented.

In fact, there is a tendency to treat the non-hardware items of a system as not requiring a research and development (R&D) effort. A suggestion that the tank skip the AD phase and go directly into Full-Scale Engineering Development (FSED) would not have been seriously considered. On the other hand, both the Skill Performance Aids (SPA) and the training devices essentially moved directly into FSED.

In summary, the relatively subordinate position of the human dimension aspects of the system acquisition cycle can be traced largely to the inability of personnel and training developers to successfully articulate their requirements to the top echelon of decision makers. They lack the priority and visibility to assert their positions and the analytic tools to gain the required attention.

5.3.2 Potential Solutions

A separate milestone schedule and budget for personnel and training subsystems subject to ASARC/DSARC review and approval could provide a vehicle for achieving priority and visibility for human dimension issues. Through this means a program manager could be held responsible for addressing personnel and training issues in as timely, effective, and cost-conscious manner as hardware issues.

In an effort to meet milestone schedules management it often required to make decisions based on less than required data; this seems to be especially true of personnel and training issues. In such cases management must be made aware of the increased risk attendant on making such decisions. One way to do this is to present a range of possible data values and associated confidence values. From such data a range of potential outcomes could be developed from best case to worst case situations.

More basic research is required on the fundamental questions of training effectiveness. While the XM1 Program employed state-of-the-art techniques for assessing the potential training effectiveness of devices and programs, the results were very subjective and of low confidence. The Army needs to institute a comprehensive program of basic research and testing, similar to the post-World War II effort on other areas (e.g., terminal ballistics research on the understanding of firepower).

Additional effort is also required to relate training effectiveness and individual performance to combat effectiveness.

Until the training developer can show his impact on the central battle in a manner similar to the engineer, hardware considerations will always overshadow human dimensions.

5.3.3 Issues

The following issues are to be explored by the study team:

1. Examine the role of contractor-produced personnel and training documentation and analysis.

Several contractor-produced personnel and training products provoked great controversy in the user community. What was the cause of these problems?

2. Examine the impact of timely submission of Training Device Requirements (TDRs).

As a result of a major internal debate at TRADOC, the development of TDRs was delayed three and a half years. Would a more timely submission have resulted in an improved training component?

3. Examine the impact of increased testing.

Inadequate data, particularly on RAM-D, has plagued the XM1 program. Would additional time for OT or Force Development Test and Evaluation (FDTE) aid the program? What is the impact of delaying critical data collection until OT III?

4. Examine the impact of improved Quantitative and Qualitative Personnel Requirements Information (QQPRI) data.

The XM1 assumed QQPRI data similar to the M60. It is now generally agreed that this is inadequate. How would improved data have effected the program?

SECTION VI MAJOR STUDY ISSUES

This section addresses the four major study issues identified by the SSB at the end of the previous section.

6.1 CONTRACTOR-PRODUCED PERSONNEL AND TRAINING PRODUCTS

Two types of contractor-produced personnel and training products are of central importance to this study: the front-end analysis (FEA) and the training manuals and technical materials.

6.1.1 Front-End Analysis

In accordance with the Instructional Systems Development (ISD) Model,¹ the first step in the development of a training program is a thorough FEA. The quality of the FEA is generally thought to have a direct bearing on the quality of the training program.

The XM1 FEA is a critical product for a variety of Army training developers, the primary of which are USAARMC (operator/organizational maintenance training), USAOC&S (DS/GS maintenance training), and PM TRADE (training devices). It has a secondary impact on TRADOC schools and centers which share training responsibilities for MOSs required by the XM1. The most prominent of these MOSs is 34G, the fire control computer repairman. The skill requirements and the training program for the 34G is of direct interest to the Signal, Field Artillery, Intelligence, Infantry, and Logistic Centers.²

In the XM1 program the vehicle for conducting the FEA was the TASA produced by Chrysler during FSED.³ The differences of opinion on the quality of the TASA are dramatic. Chrysler personnel felt that

¹ TRADOC Pamphlet 350-30, Interservice Procedures for Instructional Systems Development, 1 August 1975.

² It is likely that the 34G will soon be split into two MOSs.

³ Cf., Section IV, pp. 4-58 to 4-60 and 4-77.

they had done an outstanding job; government representatives from PMO XM1, TACOM, and HEL strongly agreed. FEA users at USAARMC, USAOC&S, and PM TRADE registered strong dissents. Few of those interviewed by the study team occupied a middle position.

A detailed evaluation of the TASA is beyond the scope of this study. Indeed, whether or not Chrysler did a "good job" on the TASA is of only peripheral interest to this study. Some comments on the quality, however, are in order. Even a cursory examination of the TASA will show that it does not completely meet the ISD requirements for an FEA. There is, for example, neither an identification of critical tasks, nor a hierarchy of skills and knowledges, nor an estimation of required training time. On the other hand, it does seem to compare favorably with government-produced TASAs for other Army systems with which the study team is familiar.

The critical contract clause governing the XM1 FEA is the DoD-approved DID DI-H-6130(MOD) on task analysis. No one interviewed by the study team expressed the opinion that Chrysler failed to satisfy the DID. The critical problem, then appears to be the selection of the contract specification, since that is what determines the contractor's legal obligation and what the contractor bases his cost estimate upon. It is certainly unfair for the government to blame a contractor for failing to provide more than is called for in the contract.

Drafting of FSED contract specifications was accomplished by the PMO,⁴ based upon guidelines in the Defense Acquisition Regulations (DARs).⁴ The ultimate responsibility, however, lay with the SSEB, a board which included TRADOC representation. The study team found no evidence of TRADOC non-concurrence with the FSED RFP. The failure to adequately articulate the TRADOC training community's FEA requirements, then, appears to be a result of a failure to communicate within TRADOC.

Another fundamental issue is the timing of the TASA. Under TRADOC's current regulations,⁵ which post-date the TASA, a contractor TASA should be supplied during Demonstration and Validation, early enough to influence T/OT I test issues. As a result of the XM1's delay of support issues until FSED, the XM1 TASA appears about one

⁴ Formerly, the Armed Services Procurement Regulations (ASPRs).

⁵ TRADOC Reg. 600-4, Integrated Personnel Support, 1 June 1978.

year before DT/OT II. This is generally consistent with XM1's other personnel and training issues being one LCSMM phase behind the hardware.

6.1.2 Training Materials and Technical Manuals

As part of the ILS package, training materials and technical manuals were postponed until FSED. This had a major impact on the XM1 program in both positive and negative ways.

While the XM1 was in AD, TRADOC was completely rethinking its concepts on training materials and technical manuals. The result was the ITDT/SPA concept. At the time of the FSED contract award only draft ITDT specifications were available and the concept was still somewhat in flux.

Had training materials and technical documentation been prepared during AD, they would certainly have conformed to the older concept and would have contributed little to any ITDT effort. At FSED the Army would have had to choose between continuing with the older concept (presumably resulting in an inferior product) or starting from scratch with the new concept (with the money expended in AD being essentially lost). Thus, due to a unique set of circumstances, omission of these materials during AD proved fortuitous.

Nevertheless, the lag of the development of these materials behind the end-item was a serious problem. Within three months of the FSED contract award, TRADOC representatives at the TIWG noted that the requirements of AR 1000-2 were in conflict with the FSED contract with respect to training and technical publications.⁶ Why TRADOC did not raise these points during the drafting of the RFP is not clear.

Another significant problem for the development of materials and manuals was the prime contractor's quality control. The problem was exacerbated by the involvement of numerous subcontractors.

As early as DT/OT I, Chrysler's training program was found to be deficient. The Chrysler program was cited as being incomplete, inaccurate, poorly prepared and scheduled, and not in accordance with Army instructional practices. At the same time, the GMC package, while not without problems, was rated considerably higher.

6 Cf. Section IV, pp. 4-54 to 4-55.

During DT/OT II the same problems reoccurred with the Chrysler training materials and technical manuals. The user does not appear to have had an opportunity to review the contractor package until shortly before the test. As a result, USAARMC invested a sizable team working on a crash basis to produce what is considered a minimally acceptable product.

6.2 TRAINING DEVICE REQUIREMENTS

Army regulations call for the concurrent development of materiel and training devices. In contrast to decisions to delay ILS, the XM1 schedule called for early action on training devices. It had been the intention of PM XM1 to incorporate TDRs into the FSED RFP. If this had been done, the device development might well have been synchronized to materiel development.

The delays which upset these plans can clearly be ascribed to TRADOC's inability to come to a decision on TDRs. There were essentially two camps in TRADOC: one, dominated by USAARMC, proposed a traditional approach to Armor training with limited use of simulation; the other, headed by TRADOC DCST, sought to introduce innovative ideas and high technology.

The ideas proposed by DCST were new and, therefore, untried and unvalidated. In some cases the technical feasibility of the approach was uncertain. Cost estimates were tentative.

The heart of the problem was that there was simply no way to decide between the traditional and the innovative approaches in a systematic, scientific way. The definition of TDRs appeared to be a matter of opinion.

The upshot was an impasse for about a year. The JWG was then set up to draft an LOA, so that work on devices could begin. The changes in the three draft LOAs that appeared between May and September 1975 illustrate the volatility of the XM1 training devices concept. Figure 6-1 shows a comparison of the first and last drafts, as well as the final TDRs. The study team was unable to find any extant analysis to support these changes, nor any indication that any such analysis was done.

The discussions over the LOA resulted in the loss of another year, at the end of which there were still no TDRs, which would take more than another year. It would be exceedingly difficult to assert

	DRAFT LOA 7 MAY 1975			DRAFT LOA 17 SEPTEMBER 1975			TDRs JULY 1977		
TRAINING FUNCTION	DEVICE	USE	COST*	DEVICE	USE	COST*	DEVICE	USE	COST**
DRIVER	DRIVER TRAINER	U,I	800	DRIVER TRAINER	I	1620	DRIVER TRAINER	I	130
TC/GUNNER	COFT	U,I	40	COFT	I	40	U-COFT OSUT- COFT	U I	125 610
FULL CREW	FCIS	U,I	1900	FCIS	I	1000	NONE		
MAINTENANCE	ORG. TVM	I	300	MULTI- MEDIA ITDT	U,I	0.073	RANGEFINDER	I	33
	ORG. TTM	I	300				COMPUTER	I	33
	DS/GS TVM	I	700				TTS	I	33
	DS/GS TTM	I	700				TOMT	I	255
							TURRET	I	33
							TRANSMISSION	I	33
							ELECTRICAL	I	33
							ENGINE	I	33

* UNIT PRODUCTION COSTS IN THOUSANDS OF FY75 DOLLARS (PM TRADE ESTIMATE)

** UNIT PRODUCTION COSTS IN THOUSANDS OF FY76 DOLLARS (PM TRADE ESTIMATE)

U= FOR USE AT UNIT LEVEL

I= FOR USE AT INSTITUTIONAL AND SPECIAL TRAINING BASE LEVEL

FIGURE 6-1. COMPARISON OF DRAFT LOAs AND TDRs

that the 3.25 year delay in the TDRs produced any significant new data or understanding of training requirements.

Once the training devices went to contract, they had to proceed on a tight schedule, to make up for lost time. In order to have the devices ready for fielding, the AD phase was omitted and the devices proceeded directly into FSED. But the devices contractors had difficulty in gaining timely access to the hardware, which in any case was still somewhat immature in design. This, combined with technical difficulties, has caused further delays. Devices will not be available for EOC.

In the case of maintenance trainers, the difficulties were particularly acute, because of the failure of the FSED test sets. The complete redesign of the test set concept meant that work previously accomplished was virtually useless. PM TRADE has estimated that approximately \$1 million was lost on maintenance trainers.

Would the timely submission of TDRs have improved the development of XM1 training devices? If the TDRs had been formulated in 1974, they would have been incorporated in the FSED RFP and funded in the FY77 budget. It seems reasonable to conjecture that, had this been the case, prototype crew training devices would have been available by the end of FSED. Under such circumstances it seems probable that the crew training devices (or at least prototypes) would have been available by EOC.

The reformulation of the maintenance test sets concept caused a major setback to the corresponding trainers. Earlier definition of TDRs in this area would appear to have been of little help to the XM1 program.

6.3 ADDITIONAL TESTING

From the point of view of this study, the most critical inadequacy of testing was the failure to determine AMMH during DT/OT II. The AMMH are required to determine the maintenance personnel sections of the QQPRI.

7 Cf. Section IV, p. 4-35.

Adequate data to assess RAM was not collected during DT/OT I, nor was it ever planned.⁸ From fairly early in the program it was planned that DT/OT II would be the critical test phase. But the pressure of the test schedule, compounded by significant mid-test changes to the end-item, prevented collection of adequate data to assess RAM during DT/OT II.

The arguments for and against the advisability/necessity for additional testing are typified by the exchanges between LEA and PMO XM1 prior to ASARC III.¹⁰ LEA found significant deficiencies and inadequacies in the testing; they concluded that the tank should not enter LRIP but remain in FSED for more testing, citing that "The basic policy for systems acquisition is that the pacing factor shall be the successful attainment of objectives rather than scheduled milestones."¹¹

The thrust of the PMO response¹² looks at the problem from an entirely different point of view. They argued that LEA did not take into account the cost and schedule constraints to which the program was subject.

Proceeding from diametrically opposed philosophical positions regarding the LCSMM, LEA and PMO XM1 reached, not surprisingly, diametrically opposed positions. LEA's position is rooted firmly in the acquisition regulations, which reaffirm that progress can only be made based upon successful completion of LCSMM events. PMO XM1's position is rooted firmly in the reality of the defense acquisition process, which recognizes that programs which violate cost and schedule constraints may be subject to major delays, cutbacks, or cancellations.

As to the question of whether or not XM1 should have had additional testing, it depends on one's position on the LCSMM. Almost everyone involved in the XM1 program would agree to the desirability of additional test data; the question is, is it worth the potential risk to cost and schedule?

⁸ Cf. Section IV, p. 4-20.

⁹ Cf. Paragraph 4.6.3.

¹⁰ Cf. Paragraph 4.8.1.

¹¹ LEA, Interim Assessment, op. cit., p. 25.

¹² Vetort, op. cit.

6.4 PERSONNEL REQUIREMENTS

Critical questions concerning requirements for organizational maintenance, DS/GS maintenance, and logistic support personnel for the XM1 remain unanswered. Even assuming that all these questions are definitively answered during DT/OT III, insufficient time remains to provide the required personnel by EOC.

PMO XM1 and TSM XM1 have expressed confidence in the ability of the current organizational maintenance personnel structure to support the XM1.¹³ Doubt, however, remains among numerous agencies, since it is based upon M60 Series data.¹⁴ Doubts raised during DT II about the adequacy of personnel skill levels have not been specially addressed.¹⁵

DS/GS personnel requirements are even less well defined. The TSM notes: "We simply have not yet stressed the direct and general support maintenance capabilities to a degree that would generate either confidence or doubt."¹⁶

Since the inception of the XM1 program it has been a stated requirement that there be no increase in support personnel. The analysis of the MBTTF supported this requirement, which was confirmed by that of the TSSG. The depth of this analysis is somewhat suspect. For example, it was known as early as 1972 that the XM1 would be about as heavy (54-58 tons) as the M60 (54.8 tons), but would be required to go faster (45 mph vs 30 mph) and have twice the horsepower (1500 hp vs 750 hp). Based on this information alone, it would seem to have been reasonable to predict in 1972 that the XM1 (whether it had a diesel or a turbine engine) would require more fuel than the M60A1; hence, more fuel trucks and fuel truck drivers.

Estimates made by TSM XM1 in the Modified Manpower Analysis Paper in late 1978 identified additional requirements amounting to over 1700 personnel, primarily truck drivers and ammunition handlers.

¹³ Day, memo to Dr. Haggard, op. cit.

¹⁴ LRR, op. cit., Vol II, p. 36.

¹⁵ Cf. Section IV, pp. 4-63 to 4-64.

¹⁶ Day, memo to Dr. Haggard, op. cit.

The final version of these figures has yet to be determined, but an examination of the interim results is of interest.¹⁷

The effect will vary from unit to unit, so the Tank Battalion (TOE 17-35H)¹⁸ will be used as an example. This version of additions to a tank battalion is:

- o 6 Fuel Truck Drivers
- o 5 Ammunition Truck Drivers
- o 3 Ammunition Handlers
- o 1 Wheeled Vehicle Mechanic.

The position of TSM XM1 is that this represents an increase of less than three percent of the currently authorized 503 enlisted positions and is, hence, insignificant. Fourteen of the fifteen additions will be assigned to the transportation section, which is a sixty-six percent increase in the currently authorized twenty-one enlisted positions. Since the total force level will not change, these additional personnel must come from other positions which have not yet been identified.

It seems clear to the study team that, had better estimates of personnel requirements been provided at the times indicated in the LCSMM, the Army's personnel planners would have had adequate time to ensure the availability of personnel to meet fielding requirements. However, it would have been necessary to delay the program to provide the required test data to support the personnel requirements. The combination of program delays and increased personnel requirements would have increased the risk of program cancellation by the Congress, especially during the period when the Leopard 2 was under consideration. As it happened, doubts about the personnel requirements did not occur until after the threat of program cancellation became negligible.

¹⁷ Estimates obtained by the study team during interviews with staff members at OCSA and MILPERCEN varied between 1300 and 2000.

¹⁸ USAARMC, US Army Armor Reference Data. ST 17-1-1. Fort Knox, KY: February 1978.

6.5 SUMMARY

To a certain extent the personnel and training subsystems of XM1 suffered from a semantics problem. In an effort to keep the program "on schedule," personnel and training milestones, in a sense, were "checked off" as if they were keeping pace with the end item. In fact, they lagged behind the hardware from the time of the decision to omit ILS in AD. As the PMO XM1 stated:

"This decision...resulted in logistical support development lagging development of the tank by one phase at the time of FSED contract award. The XM1 program¹⁹ is structured to correct this lag by EOC..."

An example of this is the Final QQPRI and Final MOS Decision. It was known some time before each was made that neither was, in fact, final, but that an Amended FQQPRI and Amended Final MOS Decision would be required. The milestones for FQQPRI and Final MOS Decision, however, could be "checked off."

Thus generally it is apparent that, while the end item was in the Demonstration and Validation Phase, the personnel and training subsystems were still exploring alternative system concepts. While the end item was in FSED, personnel and training concepts were demonstrating their potential. While the end item is in initial production, the personnel and training systems will undergo full scale testing. When the end item is fielded, the personnel and training subsystems will begin to be phased in and modified. Priority was, in effect, clearly given to the basic hardware development program for reasons stated elsewhere in this report.

¹⁹ Vetort, op. cit., Enclosure, p. 1.

SECTION VII
LESSONS LEARNED AND RECOMMENDATIONS
ON THE LCSMM

7.1 THEORY VS REALITY IN THE LCSMM

In theory, the LCSMM is an event-driven model. The pacing factor is to be successful completion of milestones. All of the regulations and acquisition guidance reviewed by the study team confirm that point of view.

The reality of the XM1 program is that it was driven by cost and schedule constraints. This is confirmed again and again in the history of the XM1.¹ The experience of the study team is that, in this respect, the XM1 is much more the rule than the exception. The highest echelons of management (HQDA, DoD, OMB, Congress) tend to concentrate on cost and schedule as measures of program success; and the acquisition community, quite naturally, is responsive to the concerns of top management.

It seems clear to the study team that the theory and the reality of the LCSMM need to be brought into closer alignment, particularly in the personnel and training areas. The remainder of this section will discuss some suggested ways and means of doing this.

In a recent report for AMSAA retired Generals Kerwin and Blanchard recommended that the LCSMM needs more discipline with respect to manpower, personnel, training, and logistics (MPT&L) issues.² They note:

"IOCs and compression of the development cycle aggravate this situation. The development process must appreciate these interrelated requirements and recognize that every time a waiver is granted or Integrated Logistic Support³ is deferred, the MPT&L issues suffer."³

¹ Vetort, op. cit. is one of the best articulations of the XM1's problems from this point of view.

² GEN Walter T. Kerwin, GEN George S. Blanchard, Dr. Erwin M. Atzinger, and Phillip E. Topper, Man/Machine Interface--A Growing Crisis. USAMSAA, APG, MD: August 1980. (Note: As Vice Chief of Staff, Army, GEN Kerwin was the Chairman of the XM1 ASARCs II and III.)

³ Ibid., p. 3.

For an alternative approach to system development, the Soviet method may be considered. The Soviets, emphasizing an evolutionary process, encourage early fielding of new models of equipment and correcting problems by product improvement and field modifications. In the area of tanks, at least, both the quantity and the quality of the Soviet fleet is generally felt to be impressive.

7.2 INTEGRATED LOGISTIC SUPPORT

In light of the history of the XM1, the study team feels that the single most critical decision concerning personnel and training issues was the postponement of ILS development until FSED. As the PMO stated:

"The approved Army program for development of the XM1 did not fully fund the development logistical support in the validation when two contractors, Chrysler and General Motors, were in competition. This decision was driven by the desire to conserve funds and resulted in logistical support development lagging development of the tank by one phase at the time of FSED contract award."⁴

This type of decision, by no means unique to XM1, has been criticized by the Kalergis Report⁵ and the Kerwin/Blanchard Report⁶ as being a false economy resulting in increased costs downstream.

The study team agrees that more effort should be applied to ILS issues in the early stages of system development. Primary responsibility for reviewing and approving ILS for new systems belongs to the DCSLOG and his field operating agency LEA. The study team feels that the DCSLOG should take a more active role in the concept formulation and advanced development stages to ensure that ILS issues are adequately addressed. The DDCSLOG should closely monitor the PMO's ILS management and ensure that adequate coordination with all appropriate Army elements has been effected. For each of the four major milestones, LEA should prepare an independent critical assessment, similar to the XM1 Interim Assessment.

7.3 ESTABLISHING CONTRACT SPECIFICATIONS

The XM1 was one of the Army's first major system acquisitions to employ the philosophy of increased contractor responsibility for

⁴ Vetort, op. cit., p. 1.

⁵ Kalergis, et. al., op. cit., p. V-17.

⁶ Kerwin, et. al., op. cit.

design. As a result, some items that had traditionally been developed in-house (e.g., FEA, training manuals) were assigned to the contractor. The development of contract specifications was later to cause problems. In the case of the FEA, the DID failed to call for certain items considered essential by users. In the case of training materials and technical manuals the contractor was excused from performing formal validation. For logistic data the contractor was not funded for a full LSA/LSAR.

Based upon the interviews conducted by the study team, it appears that many of the users of contractor products were not aware that the contract did not address all their requirements until after the products were produced. While there is generally extensive review of in-house requirements documents by TRADOC, it appears that the FSED RFP (upon which the FSED contract was based) did not receive close scrutiny from some of the users of FSED products.

If contractors are to continue to assume extensive authority over system design, then it is imperative that all of the product users have an opportunity to review appropriate portions of the RFP before it is released. Primary responsibility for undertaking this review should be assigned to the User's Representative--TRADOC. The TSM seems to the study team to be the logical person to coordinate this activity.

7.4 IMPACT OF PERSONNEL AND TRAINING ISSUES

In the course of the XM1 program personnel and training events were often significantly delayed (e.g., TDRs) or performed in an unsatisfactory manner (e.g., QQPRI). Similar sorts of delays in hardware-related events would not have been tolerated. In this respect XM1 again appears to be typical of major systems development. If personnel and training subsystems are to be more successfully integrated into total system development, it is important to understand why this is the case.

The study team believes that there are three basic reasons for this situation:

- (1) The training community has not been able to quantify training requirements in an objective, scientific manner.

- (2) The impact of training and personnel issues on battle outcome has not been quantified.
- (3) Personnel and training issues receive low visibility at top management echelons during the earlier stages of system development.

Each of these points will be discussed in turn.

7.4.1 Quantifying Training Requirements

The definition of training requirements is still more an art than a science. The lengthy delays over the XM1 TDRs illustrates this point well. The scientific evidence available to support the decision in 1977 was not significantly different from that available in 1974. The decision was based primarily on the intuition of key decision makers in the training community; well informed, intelligent intuition by experienced persons, but not demonstrably quantified or objective. The state-of-the-art does not currently allow a better approach at a reasonable cost.

The study team believes that the establishment of an objective, empirically-based, scientific approach to determining training requirements in a quantitative manner would improve both the quality and the credibility of personnel and training related decisions during systems acquisition. This is not to imply that such approach could be established either quickly or easily.

An analogy can be drawn to the condition of terminal ballistics research immediately after World War II. The Army then recognized that its scientific understanding of firepower fell far short of requirements. To remedy the situation a major test program was initiated under the direction of the Ballistics Research Laboratory to establish a data base for ballistics analysis.

A similar effort is required for personnel and training analysis. A major program of basic research should be undertaken by the Army to establish a personnel and training requirements data base. Among the topics that should be covered are: fidelity requirements for training devices, the relationships between aptitude testing and task performance, time to train, and media selection.

⁷ Cf. Paragraph 4.4.2.

7.4.2 Quantifying the Impact on Battle Outcome

Given the choice between procuring a weapon and procuring a training device, many top defense managers will opt for the weapon, on the grounds that a training device "won't kill anything." Is this a valid argument? Many in the training community think not, because a well trained crew may be far more deadly (and survivable) than a poorly trained one. In that sense, the training device may, in fact, "kill things." The question, then, is how to demonstrate this?

The study team believes that this can best be achieved by developing combat models and simulations which employ parameters sensitive to variations in human performance. The output of such models and simulations should be in terms of the traditional measures of effectiveness employed by combat models (e.g., loss-exchange ratios, acquisition/loss of territory, battle length). In this way variation of training impacted parameters could be directly compared to and traded-off against hardware considerations.

An example of a useful application of such a model would be the question of fielding the XM1 tank before the availability of adequate training devices, test sets, technical materials, and support personnel. An XM1 degraded in performance due to these inadequacies could be compared to the current M60A1 or M60A3 tanks at current performance levels. If the degraded XM1 proved to be more effective, then it should be fielded immediately, if less, the fielding could profitably be delayed while shortfalls are corrected.

A major research effort is required to develop the necessary modeling capability, although some of the models currently in use reflect certain training related parameters. For example, CARMONETTE (the primary model used for the XM1 COEAs) can reflect variations in such parameters as acquisition time.

The combination of a training requirements data base and a training impact modeling capability would be a particularly powerful combination for assessing training impact.

7.4.3 Visibility of Personnel and Training Issues

It is natural that project managers are most responsive to the requirements of greatest concern to the higher levels of management. The surest way to increase the effort applied to personnel and training issues is to bring them to the attention of top

management. In order to do this effectively personnel and training issues need to be introduced into the regular reporting channels used by top DoD management and the Congress. Documents such as the Selected Acquisition Reviews (SARs) and the DA Program Reviews (DAPRs) should incorporate personnel and training milestones and objectives. In this way, failure to meet these milestones and objectives would receive scrutiny at the highest levels.

SECTION VIII
LESSONS LEARNED AND RECOMMENDATIONS
ON THE RESEARCH METHOD

The SSB briefing was held on 20 May 1980 at SAI/McLean with observers from ARI Headquarters and the Fort Knox Field Unit. The consensus of opinion of the SAI participants was that the briefing was highly successful, representing both the dynamics and the organizational perspectives.

This is not to say, however, that there could not have been improvements either in the execution of the proposed method or in the method itself. The technique of role playing is, of course, not new; but its application to examining the system acquisition cycle is rather experimental. It is hoped that the lessons learned from the study may be useful in improving the method for other applications.

The method was greatly aided by the fact that most of the advocates have in the past been associated with the areas they represent. The Materiel Developer Advocate is a former chief of the XM1 Washington Field Office; the Operational Tester Advocate recently retired as chief of OTEA's Plans and Policy Branch; the Logistician Advocate is a former Army logistician with long experience in working with LEA; the Proponent Advocate has been working primarily with TRADOC Schools and Centers for the last five years. These advocates brought with them both a knowledge of XM1 personnel and events as well as a personal bias toward the area they represented.

While some lively and pointed discussions were held during the briefing, there was much less conflict among the advocates than was originally envisioned. This, however, seems to be a reflection of the XM1 Program itself. While there was considerable difference of opinion among the six areas on how to accomplish certain requirements and on program priorities, there was a unanimous and almost passionate commitment to producing the XM1 on time and within cost ceilings. In fact, some of the most severe disagreements occurred not between advocate areas, but within a single area (e.g., TRADOC's internal disagreements over training device requirements).

The most significant shortcoming in the execution of the method was the amount of time allowed for the SSB briefing. Originally, an entire day was to be set aside for the briefing with additional time for the SSB to meet on the next day. For a number of

administrative and financial reasons, the schedule was reduced to four hours for the briefing. As a result, the briefing ran behind schedule and took nearly six hours. Even at that, there was insufficient time for discussion. At least 1-1/2 to 2 days should have been set aside for the briefing and discussions. Although this may have resulted in a weakening of the portrayal of the dynamic aspects of the development cycle, a more illuminating discussion would have resulted.

The SSB members were purposefully not kept informed of development of the study until the time of the audit trace. The idea was to bring them into the briefing with a minimum amount of predisposition to the findings. In retrospect, it seems that some effort should have been expended prior to the briefing on familiarizing the SSB members with the structure and facts of the XM1 Program. This would have allowed the briefing to move through the historical facts more quickly and concentrate on the issues. A briefing book and a pre-brief discussion by the Principal Investigator (PI) may be the best way to accomplish this.

The briefing was divided into a number of phases corresponding to phases in the acquisition cycle. At the beginning of each phase, each Advocate involved in that phase presented his area in turn; the panel discussion followed the presentations. In retrospect, this was too confusing. A single narrator presenting the events of each phase (in the manner of Section IV), followed by a panel discussion among the Advocates, would have been clearer and more concise.

One Advocate with a surfeit of enthusiasm found it impossible to keep from jumping out of his role to express his own opinion, even when quite unrelated to his area. This should be guarded against.

It was envisioned from the beginning of the project that some advocates would have a much larger role than others. Those representing TRADOC and DARCOM were clearly the key players. Since the others had much smaller roles to play, they were involved in the project only on an as-required basis. In retrospect, the project might have been better served if the Operational Tester, Logistician, and Executive Management advocacies had been consolidated into one advocate (representing HQDA and staff agencies) who could have been involved in the project on a more continuous basis. This should result in discussions of greater balance among the advocates. Of course, this could mean the loss of some interesting OTEA and LEA perspectives. The point is arguable.

The PI wore two hats in this study. As the Proponent Advocate he researched and represented TRADOC. As the study manager he accompanied all other advocates on interviews and reviewed all data. It would seem to be better to separate these two functions. The PI, having the broad overview of all the interviews and data, would better serve as the briefing discussion leader or chairman of the SS8. This, of course, would require a substantial increase in the amount of resources devoted to the study.

APPENDIX A XM1 SYSTEM DESCRIPTION

The XM1 Abrams Tank¹ will be a sophisticated, highly reliable, highly mobile, full-tracked armor fighting vehicle incorporating improvements in fire control, powerplant, suspension system, and armor protection. It will consist of a hull and a turret (fighting compartment) and will be operated by a four person crew (driver, gunner, loader, and tank commander).

A.1 FIRE CONTROL

A.1.1 Stabilization

The XM1 achieves its ability to fire accurately on the move by stabilizing the main gun to a stabilized gunner's sight. The head mirror, which receives both the day and night optical images, is controlled by a direct-drive electric motor to eliminate the effects of backlash. A two-axis-rate gyro provides the spatial reference necessary for stabilization. It is platform-mounted in the sight and is connected to the mirror through a tape drive at 2:1 ratio. The servo bandwidth of the head mirror drive is thirty-five hertz. This is sufficient to stabilize the line of sight to a 0.10 mrad sigma when driving cross country.

The power for the stabilization system is taken off the engine to drive a pressure compensated pump, which delivers forty-seven gal/minute at 1650 psi. The control system is of the proportional type, incorporating integral and differential control compensation. The pitch rate is sensed by the turret gyro and fed forward to reduce velocity lag error.

Electrical gates have been built into the system to inhibit the trigger when the gun is out of stabilization axis by more than 0.25 mil elevation or 0.3 mil azimuth.

¹ The primary reference for Paragraphs A.1-A.4 is MG Donald M. Babers, "(S) XM-1, Main Battle Tank of the Future (U)" in Journal of Defense Research: Armored Fighting Vehicles (U), Robert A. Stein, Ed., Special Issue 79-1: January 1980. (SECRET--NO FOREIGN DISSEMINATION)

A.1.2 Ballistic Computer

A ballistic computer system has been developed for the XM1 which will solve for sight parallax, lead, and superelevation. The computer senses the cant (for static firing only), target slant range, tracking rates for leading a moving target automatically when the gunner tracks the target) ammunition type, and tube wear.

The system further automatically administers a self check and indicates malfunction in the sight. This system is not dependent on the computer to function. A numeric problem code is displayed to the operator to assist diagnosis. The computer contains a six thousand word solid state memory. A sixteen-bit central processing unit (CPU) provides high reliability at low cost. The computer receives air temperature, air pressure, powder temperature, and gun muzzle position through manual inputs from sensors. Cant and crosswind are sensed directly by the computer.

Cant is measured by a damped-pendulum device. Crosswind is obtained with an ion drift type sensor. The wind-drift values are filtered differently when the vehicle is stationary or moving to allow the moving data to be based on a shorter interval.

A.1.3 Azimuth Lead

In order to hit a moving target it has been shown that the greatest dividends derive from using the computer to develop a proper lead based on target motion sensed from holding the sight on the moving target.

By sensing the motion of the target with a potentiometer and a tachometer the ballistic computer can (based on range from the laser range finder) determine the proper lead and offset the target reticle appropriately.

A.2 POWERPLANT

The designers of the XM1 were faced with a dilemma in weight/agility trade-offs. The greater survivability of more armor carries a penalty of more weight which is in conflict with the goal of increasing survivability through more agility. Not only is a larger engine implied by heavier armor it is also implied by more agility. However, a larger engine itself means more weight which further aggravates the problem. To make a major inroad into this constraint

the XM1 utilizes a twenty-five hundred pound regenerative cycle gas turbine engine which can produce fifteen hundred hp with a two thousand pound saving in engine weight over a comparable diesel engine. Less engine weight can therefore be used for more armor. The horsepower available from the gas turbine allows the XM1 to have twenty-five horsepower per ton versus the fifteen horsepower per ton available from the M60.

The engine has a two-spool gas producer, a free power turbine, a stationary recuperator, and internal reduction gears. The five-stage axial flow, low-pressure compressor is driven on the inner shaft by the one-stage low-pressure turbine from 11,900 rpm at idle to 31,500 rpm at rated speed. On the counterrotating outer shaft, the high pressure compressor, consisting of four decreasing-diameter axial flow stages and a single centrifugal stage, is driven by the single-stage high pressure turbine at 24,400 rpm at idle and 43,900 rpm at rated speed. The two-stage power turbine, which rotates at 3,260 rpm at idle and 24,500 rpm at rated speed is spliced to a single-stage planetary reduction gear which provides the output of 870 rpm at idle and 3000 rpm at rated speed. Standard idle allows the vehicle to move at a creep speed of 2.5 mph for operations with dismounted infantry forces. The vehicle accelerates to twenty mph in 6.2 seconds from idle and the maximum vehicle speed is governed to forty-five mph.

The fuel metering, inlet guide vane setting on the low pressure compressor, and power turbine stator positioning are all controlled by a computer which senses engine temperatures, compressor speeds, and driver demands.

This allows the engine to be efficient at partial power as well as peak power through variable vane settings at the compressor and power turbines and through a decoupled low pressure and high pressure compressor.

The electronic engine control system also amplifies the engine by eliminating many moving parts.

In spite of the engine's efficiency relative to other turbines however, it will use six to twenty-five percent more fuel than a comparable diesel engine.

A bonus of the turbine is its relative quiet and smokeless operation. Although the turbine ingests twice as much air as a

diesel, requiring more filter elements, the combined requirements for cooling are lower. A turbine is actually less sensitive to dust ingestion than a diesel.

A.3 SUSPENSION

The suspension system features seven roadwheel stations which allow each wheel to have a smaller diameter thus reducing vehicle silhouette. A twenty-inch roadarm allows a jounce travel of fifteen inches to allow high speed cross country travel while retaining the cost and maintenance advantages of torsion bar suspension. The high wheel travel gives the XM1 the capability to move cross country at high speeds while still retaining control of the tank and being able to fire the gun.

This stability is also made possible by the use of rotary shock absorbers which allow damping torque to be proportional to roadarm velocity, and allow heat to be rapidly dissipated into the vehicle hull.

The XM1 track consists of seventy-eight shoes per side. it has a double pin, double block, integral pad configuration similar to that of the T-97 track used on the M60 series of tanks, but it is narrower and has a large pitch. With a wheelbase of one hundred eighty inches and a nominal wheel load of eighty-six hundred pounds, the XM1 tanks soft-soil ground pressure is 13.3 lb/sq. in.

The suspension uses thirty-two identical wheels per tank - twenty-eight for roadwheels and four for idler wheels. The wheel has a molded rubber tire and a diameter of twenty-five inches; and it is made of aluminum for minimum weight. The mounting circle for the wheel is identical to that of the M60, and in emergency situations the M60 wheel can be used when this becomes necessary, even though it is twenty-six inches in diameter.

A.4 ARMOR

Perhaps the biggest change in tank technology since the M60 development is in the area of armor. The qualities of the special armor are highly classified, however it does increase the resistance to penetration. Spaced armor is also used in several places to protect key components. Compartmentalization of both fuel and ammunition further increases crew and critical component survivability. Ammunition is in several compartments, separated from

the crew, with blowoff vents to relieve explosion pressures. Each round is stored in a separate aluminum sleeve to protect neighboring rounds from sympathetic explosions due to spall.

Fuel is also compartmented in several units to reduce the danger of a catastrophic destruction of the tank. Sponson tanks gravity feed the engine to avoid fuel pressurization within the crew compartment during combat. Fire extinguishers are activated by infrared optical sensors within one hundred fifty m.sec.

In order to utilize special armor wherever possible and remain with an absolute weight limit, the XM1 uses aluminum wherever this satisfies ballistic protection requirements.

A.5 TRAINING DEVICES

This section describes the training devices to be developed for the XM1 based upon the approved Training Device Requirements. Recent changes to some support equipment concepts will lead to some changes in troubleshooting trainer requirements.

A.5.1 Conduct of Fire Trainer for One Station Unit Training

This training device will allow one instructor to teach target acquisition, identification, and engagement to ten gunners at stations which are accurate representations of the gunner's position in the XM1 tank, including the visual and audio feedback of the fire control equipment.

Each station is individually controlled by a series of programs of varying difficulty according to trainee progress. The visual simulation is to provide a target scene of multiple and varied targets (as well as friendly equipment) with appropriate terrain and vegetation. The visual presentation must also be able to simulate the motion of the gunner's tank for fire-on-the-move training.

A.5.2 Driver Trainer

The driver trainer will allow one instructor to monitor five students at stations which duplicate the driver's compartment. Visual and audio simulations will provide the student "the illusion of driving the XM1 tank." The audio and visual feedback should respond to student control movements.

A.5.3 Unit Conduct of Fire Trainer

This shelter-mounted simulator will provide training in target acquisition, identification, and engagement with either primary or alternate fire control and sighting equipment, in either the stabilized or non-stabilized mode. Student actions will be monitored by an instructor station which replicates the students visual simulation and which can insert faults. The target scene will have the same requirements for realistic targets, terrain, and vegetation as the Conduct of Fire Trainer for One Station Unit Training.

A.5.4 Tank Turret Organization Maintenance Trainer

This trainer will facilitate student inspection, troubleshooting, installation and removal, purging, and performance of proper organizational maintenance procedures as contained in technical publications. The trainer will either use or faithfully simulate turret armaments, fire control systems, turret electrical systems, turret hydraulic systems and controls, elevating and traversing systems, stabilization systems, optics, wiring and control boxes, and intercoms and radios. The trainer will allow two faults to be inserted, which can be tested and corrected using the test equipment and tools specified in the organizational maintenance manual.

A.5.5 Troubleshooting Simulators

These simulators allow the instructor to demonstrate and for the student to practice troubleshooting of the system. They include actual controls, fluid flows, electrical current flows, and auditory cues as appropriate to simulate normal operation and operation with easily inserted faults. Actual or simulated diagnostic equipment provides readout appropriate to either normal operation or the simulated fault. These simulators record and score student performance. A troubleshooting simulator will be provided for:

- X1100-3B Transmission Maintenance Trainer
- Hull Electrical System
- Engine
- Laser Range Finder
- Ballistic Computer
- Thermal Sight
- Turret Trainer (DS/GS).

APPENDIX B
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APPENDIX C LIST OF ACRONYMS

A	Availability
ACR	Armored Cavalry Regiment
ACSFOR	Assistant Chief of Staff for Force Development (HQDA)
AD	Advanced Development
AIT	Advanced Individual Training
AMC	US Army Materiel Command
AMMH	Annual Maintenance Man-Hours
AMSAA	US Army Materiel Systems Analysis Activity
AOS	Add-On Stabilization
AP	Acquisition Plan
APC	Armored Personnel Carrier
APG	Aberdeen Proving Ground
AQQPRI	Amended Qualitative and Quantitative Personnel Requirements Information
AR	Army Regulation
ARI	US Army Research Institute for the Behavioral and Social Sciences
ASARC	Army Systems Acquisition Review Council
ASD(MRA&L)	Assistant Secretary of Defense (Manpower, Reserve Affairs, and Logistics)
ASI	Additional Skill Identifier
ASPR	Armed Services Procurement Regulation
ATGM	Anti-Tank Guided Missile
ATSC	US Army Training Support Center
AVCSA	Assistant Vice Chief of Staff, Army
BCT	Basic Combat Training
BDMSC	BDM Services Company
BITE	Built-In Test Equipment
BOIP	Basis of Issue Plan
BOIP-T	Tentative Basis of Issue Plan
BTA	Best Technical Approach
CAA	US Army Concepts Analysis Agency
CAC	US Army Combined Arms Center
CDC	US Army Combat Developments Command
CFP	Concept Formulation Package
CG	Commanding General
CGI	Computer Generated Imagery
CMF	Career Management Field
COEA	Cost and Operational Effectiveness Analysis
COFT	Conduct of Fire Trainer
CONARC	US Continental Army Command
CONUS	Continental United States
CPU	Central Processing Unit
CRD	Chief of Research and Development (HQDA)

CSA	Chief of Staff, Army
CTEA	Cost and Training Effectiveness Analysis
CTP	Coordinated Test Program
CTT	Combat Training Theater
DA	Department of the Army
DAPR	DA Program Review
DAR	Defense Acquisition Regulation
DARCOM	US Army Materiel Development and Readiness Command
DASC	DA System Coordinator
DASSO	DA System Staff Officer
DCP	Decision Coordinating Paper, or Development Concept Paper
DCSLOG	Deputy Chief of Staff for Logistics (HQDA)
DCSOPS	Deputy Chief of Staff for Operations and Plans (HQDA)
DCSPER	Deputy Chief of Staff for Personnel (HQDA)
DCSRDA	Deputy Chief of Staff for Research, Development, and Acquisition (HQDA)
DCST	Deputy Chief of Staff for Training (TRADOC)
DEP	Draft Equipment Publications
DID	Data Item Description
DoD	Department of Defense
DoDD	DoD Directive
DoDI	DoD Instruction
DP	Development Plan
DPTDR	Draft Proposed Training Device Requirement
DS	Direct Support
DSARC	Defense Systems Acquisition Review Council
DT	Developmental Test
DTD	Director of Training Development (USAARMC)
DT&E	Developmental Test and Evaluation
DVAL	Demonstration and Validation
ED	Engineering Development
EOC	European Operational Capability
ETM	Extension Training Material
FCIS/-L)	Full Crew Interaction Simulator (Laboratory)
FDTE	Force Development Test and Evaluation
FEA	Front-End Analysis
FORSCOM	US Army Forces Command
FQQPRI	Final Qualitative and Quantitative Personnel Requirements Information
FRG	Federal Republic of Germany
FSED	Full Scale Engineering Development

GAO	General Accounting Office
GMC	General Motors Corporation
GS	General Support
HE	High Explosive
HEAT	High Explosive Anti-Tank
HEL	US Army Human Engineering Laboratory
HFE	Human Factors Engineering
HFEA	Human Factors Engineering Analysis
hp	horsepower
HQ	Headquarters
HQDA	Headquarters, Department of the Army
ICTP	Individual and Collective Training Plan
IEP	Independent Evaluation Plan
IER	Independent Evaluation Report
IFV	Infantry Fighting Vehicle
ILS	Integrated Logistic Support
IOC	Initial Operational Capability
IPCE	Independent Parametric Cost Estimate
IPR	In-Process Review
IPS	Integrated Personnel Summary
ISD	Instructional Systems Development
ITDT	Integrated Technical Documentation and Training
JPG	Job Performance Guides
JPM	Job Performance Measures
JWG	Joint Working Group
LCSMM	Life Cycle System Management Model
LEA	US Army Logistics Evaluation Agency
LOA	Letter of Agreement
LOGC	US Army Logistics Center
LRIP	Low Rate Initial Production
LRR	Logistics Readiness Review
LSA	Logistic Support Analysis
LSAR	Logistic Support Analysis Record
M	Maintainability
MAC	Maintenance Allocation Chart
MACRIT	Maintenance Criteria
MAP	Manpower Analysis Plan
MBT	Main Battle Tank
MBTTF	Main Battle Tank Task Force

MENS	Mission Element Need Statement
MICV	Mechanized Infantry Combat Vehicle
MILPERCEN	US Army Military Personnel Center
MIRAT	MILPERCEN Initial Recruit and Training
MMH	Maintenance Man-Hours
MN(ED)	Materiel Need (Engineering Development)
MOS	Military Occupational Skill
MOU	Memorandum of Understanding
MRDC	US Army Medical Research and Development Command
MRSA	US Army Materiel Readiness Support Activity
MTP	Manufacturing Methods and Technology Program
MTD	Materiel Test Division (TECOM)
MTT	Mobile Training Team
NATO	North Atlantic Treaty Organization
NCOES	Non-Commissioned Officers Education System
NET	New Equipment Training
NETP	New Equipment Training Plan
OAFM	Office of Armor Force Management
OAP	Outline Acquisition Plan
OAVSCA	Office of Assistant Vice Chief of Staff, Army
OCSA	Office of the Chief of Staff, Army
ODCSLOG	Office of the DCSLOG
ODCSOPS	Office of the DCSOPS
ODCSPER	Office of the DCSPER
ODCSRDA	Office of the DCSRDA
ODP	Outline Development Plan
OFPP	Office of Federal Procurement Policy
OMB	Office of Management and Budget
OPFOR	Opposing Forces
OSA	Office of the Secretary of the Army
OSD	Office of the Secretary of Defense
OSUT	One Station Unit Training
OT	Operational Test
OTEA	US Army Operational Test and Evaluation Agency
OTP	Outline Test Plan
OT&E	Operational Test and Evaluation
O&O	Organizational and Operational
PEP	Producability Engineering and Planning
PI	Product Improved, or Principal Investigator
PM	Project Manager

PMO	Project Management Office
POI	Program of Instruction
PQQPRI	Preliminary Qualitative and Quantitative Personnel Requirements Information
PQT-G	Proving Qualification Test--Government
PT/ME	Physical Teardown/Maintenance Evaluation
QQPRI	Qualitative and Quantitative Personnel Requirements Information
R	Reliability
RAM	Reliability, Availability, Maintainability
RAM-D	Reliability, Availability, Maintainability, Durability
RFP	Request for Proposals
RISE	Reliability Improved Selected Equipment
ROC	Required Operational Capability
R&D	Research and Development
SA	Secretary of the Army
SAG	Study Advisory Group
SAI	Science Applications, Incorporated
SAR	Selected Acquisition Report
SECDEF	Secretary of Defense
SM	Soldiers Manual
SPA	Skill Performance Aids
SQI	Special Qualification Index
SS	System Safety
SSB	Senior Scientist Board
SSEB	Source Selection Evaluation Board
SSG	Special Study Group
STF	Special Task Force
TACED	Tank Appended Crew Evaluation Device
TACOM	US Army Tank-Automotive Command
TAD	Training Analysis Division (USAARMC)
TARCOM	US Army Tank-Automotive Materiel Readiness Command
TASA	Task and Skill Analysis
TCP	Training Concept Plan
TDP	Test Design Plan
TDR	Training Device Requirement
TEC	Training Extension Course
TECOM	US Army Test and Evaluation Command
TET	Training Evaluation Team

TFMG	Tank Forces Management Group
TFMO	Tank Forces Management Office
TI	Texas Instruments
TIS	Thermal Imaging System
TIWG	Test Integration Working Group
TM	Technical Manual
TMI	Training Management Institute
TMOS	Tentative MOS Decision
TOA	Trade-Off Analysis
TOD	Trade-Off Decision
TOE	Table of Organization and Equipment
TOMT	Turret Organizational Maintenance Trainer
TP	Test Plan
TRADE	Training Devices
TRADER	Training Devices Requirements Office
TRADOC	US Army Training and Doctrine Command
TRAINVICE	Training Devices Model
TSARC	Test Schedule and Review Committee
TSM	TRADOC System Manager
TSP	Training Support Package
TSSG	Tank Special Study Group
TSP	Training Support Package
TSWG	Training and Support Working Group
TTD	Tank Training Device
TTM	Tank Turret Mechanic
TTS	Tank Thermal Sight
TVM	Track Vehicle Mechanic
TWGSS	Tank Weapon Gunnery Simulation System
T&E	Test and Evaluation
U-COFT	Unit Conduct of Fire Trainer
UII	Unified Industries, Incorporated
UK	United Kingdom
USAARMC	US Army Armor Center
USAARMS	US Army Armor School
USACAA	US Army Concepts Analysis Agency
USAOCUS	US Army Ordnance and Chemical Center and School
USAOC&S	US Army Ordnance Center and School
USAOTEA	US Army Operational Test and Evaluation Agency
USAREUR	US Army, Europe
USATECOM	US Army Test and Evaluation Command

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